RESPONSE ACTION CONTRACT

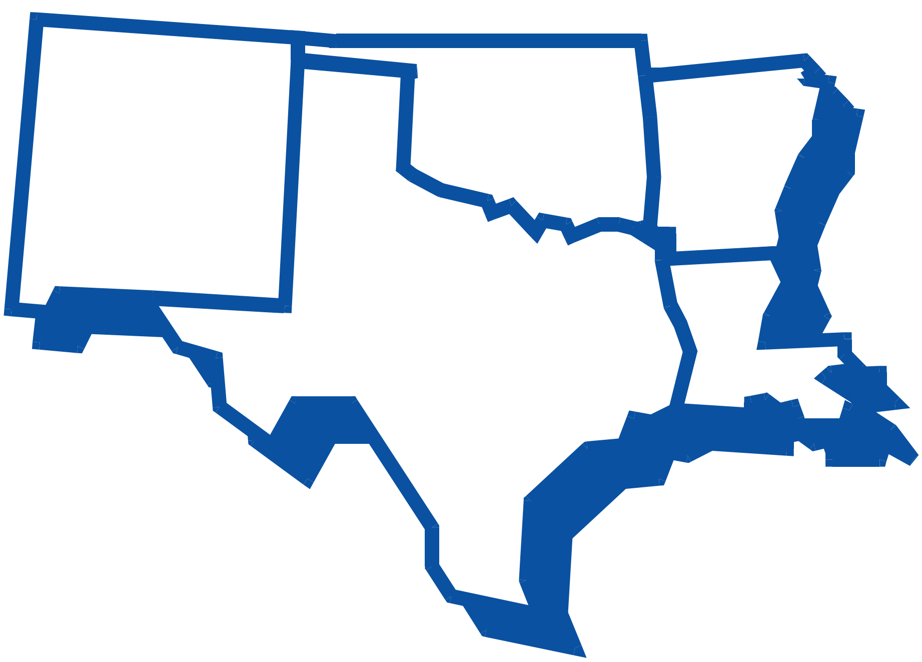
United States Environmental Protection Agency Region 6

Contract No. 68-W6-0036

Version 1.0
Focused Feasibility Study
State Marine Superfund Site

EPA Work Assignment No. 139-RICO-06BX
DCN 05-7900

July 2005



CH2MHILL

In Association With:
Science Applications International Corporation
Geo-Marine, Inc.

951719

005572

(This page intentionally left blank.)

Table of Contents

List of Tables

List of Figures

List of Exhibits

List of Appendices

Acronyms

µg/L	Micrograms per liter
95% UCL	95 Percent Upper Confidence Limit
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Aboveground Storage Tank
AUF	Area Use Factor
BERA	Baseline Ecological Risk Assessment
bgs	Below ground surface
BPF	Baseline Problem Formulation
bss	Below sediment surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of concern
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CQC/CQA	Construction Quality Control and Assurance
CRQL	Contract Required Quantitation Limit
CSM	Conceptual Site Model
CT	Central Tendency
CWA	Clean Water Act
DOI	Department of Interior
ELCR	Excess Lifetime Cancer Risk

ELCR	Excess Lifetime Cancer Risk
ELV	Estimated Limit Values
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ESI	Expanded Site Inspection
FFS	Focused Feasibility Study
FR	Federal Register
GRA	General Response Action
$^{GW}GW_{Ing}$	TRRP Tier 1 Commercial/Industrial PCL for Ground Water Ingestion
HEA	Habitat Equivalency Analysis
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking Scoring
IRIS	Integrated Risk Information System
LDR	Land Disposal Restriction
LOAEL	Lowest Observed Adverse Effect Level
LPAH	Low Molecular Weight PAH
LRC	Lauren Refining Company
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	Milligrams per liter
MNA	Monitored Natural Attenuation

MSSL	Media Specific Screening Level
N&E	Nature and Extent
NAAQS	National Primary and Secondary Ambient Air Quality Standards
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEBA	Net Environmental Benefit Analysis
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFRAP	No Further Remedial Action Planned
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
NRC	U.S. National Research Council
NRDA	Natural resource damage assessment
NSPS	New Source Performance Standards
O&M	Operations and Maintenance
OPA	Oil Pollution Act
OSHA	Occupational Safety and Health Act
PA	Preliminary Assessment
PBLS	Palmer Barge Line Superfund Site
PCB	Polychlorinated Biphenyl
PCL	Protective Concentration Level
PCP	Pentachlorophenol
ppm	parts per million

PPRTV	Provisional Peer-Reviewed Toxicity Value
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfDs	References Dose
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSD	Risk Specific Dose
SARA	Superfund Amendments and Reauthorization Act
SCM	Site Conceptual Model
Site	State Marine Site
SMS	State Marine Superfund Site
SQL	Sample Quantitation Limit
SSI	Screening Site Inspection
SUF	Site Use Factor
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	To Be Considered
TCEQ	Texas Commission on Environment Quality
TCL	Target Compound List
TDWR	Texas Department of Water Resources
TLV	Threshold Limit Values

TMV	Toxicity, Mobility, and Volume
TNRCC	Texas Natural Resource Conservation Commission
TPDES	Texas Pollutant Discharge Elimination System
TRRP	Texas Risk Reduction Program
TRV	Toxicity Reference Value
TWA	Time Weighted Average
TWC	Texas Water Commission
USC	U.S. Code
UTS	Universal Treatment Standards
VOC	Volatile Organic Compound
WAM	Work Authorization Manager
Weston	Weston Solutions Inc

(This page intentionally left blank.)

1. Introduction

This report presents the results of a Focused Feasibility Study (FFS) at the State Marine Superfund Site (SMS) in Port Arthur, Texas. The FFS was conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C., Section 9601 et. seq., and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR), Part 300.

1.1 Organization of Report

The FFS is organized into the following subsections:

Section 1 - Introduction

Section 2 – Development of Remedial Action Objectives (RAOs) and Preliminary Remediation Goals (PRGs)

Section 3 – Development and Screening of Alternatives

Section 4 – Analysis of Remedial Alternatives

Section 5 - References

The scope of the FFS includes establishing RAOs, identifying and screening applicable or relevant and appropriate requirements (ARARs), screening appropriate technologies, developing remedial alternatives, preparing a detailed and comparative analysis of remedial alternatives, and creating an order of magnitude cost estimate for the alternatives.

The content and conclusions of these activities were developed using existing information obtained from the following sources: EPA Project Files for State Marine, Texas Commission on Environment Quality (TCEQ) Project Files for the State Marine Superfund Site, City of Port Arthur files, the 1999 Technical Memorandum written by CH2M HILL for the State Marine Superfund Site (CH2M HILL, 1999), a Remedial Investigation (RI) conducted by WESTON Solutions Inc. completed in 2003 (WESTON, 2003),and historical aerial photographs (City of Port Arthur, 1998). The TCEQ was formerly known as the Texas Natural Resource Conservation Commission [TNRCC], the Texas Department of Water Resources [TDWR], and the Texas Water Commission [TWC]). For the purposes of this document, the terms TCEQ and TNRCC will both be used as applicable to the historical timeframe of the specific reference.

1.2 Site Background

During a routine aerial surveillance of Jefferson County in July 1980, the State Marine Site (Site) was identified as a potentially hazardous waste site. The Site was a barge maintenance and cleaning and salvage facility. As a result of subsequent investigations by TNRCC, the Site became a Listed Hazardous Waste Site. Following TNRCC scoring efforts in 1987 and later in 1992 (then the TWC) using the Hazard Ranking Scoring (HRS) system, the Site was referred to EPA Region 6 because the Site scored a 50.00 under the new HRS, indicating eligibility for listing on the National Priorities List (NPL). The EPA completed two separate HRS efforts, the last of which occurred in 1997. The Site was officially placed on the NPL on August 27, 1998. In June 1998, EPA requested CH2M HILL to conduct a preliminary Remedial Investigation/Feasibility Study (RI/FS) and prepare a Technical Memorandum.

1.2.1 Site Location and Description

The Site is located on Old Yacht Club Road, Pleasure Islet, within the City of Port Arthur, Jefferson County, Texas. Pleasure Islet is a peninsula located approximately one-half mile southwest of the confluence of the Neches River and Sabine Lake (**Figure 1-1**). The Site is approximately 17.2 acres in size and consists of tracts 3 and 6 on Old Yacht Club Road (Jefferson Country Appraisal District, 1998). The Sabine-Neches Canal forms the eastern border of the Site. The Site is bordered to the north by Palmer Barge Lines, to the west by Old Yacht Club Road, and to the south by undeveloped land owned by the State Marine property owner (**Figure 1-2**).

The Islet is a manmade landmass, consisting of dredge spoils generated during the construction and maintenance of the Sabine-Neches Canal. The canal was constructed between 1898 and approximately 1920, in the vicinity of Sabine Lake and the Neches River, between the current Site location and the mainland (Port Arthur Historical Society, 1997).

Pleasure Islet did not exist at the time as the area encompassing the Site was actually part of the northern tip of Pleasure Island. Between 1955 and 1957, a portion of the canal along the western side of Pleasure Islet was abandoned and a new canal cut along the eastern and southern sides of Pleasure Islet. Pleasure Islet was created when a land bridge was constructed across the abandoned portions of the canal, between the northern tip of Pleasure Island and the mainland.

1.2.1.1 Topography

Ground elevations range from sea level along the shoreline to a maximum of 11 feet above mean sea level in the northcentral portions (Engineer's Office, City of Port Arthur, 1998). The highest relief on Pleasure Islet is associated with the City of Port Arthur's former municipal landfill, which underlies most of the central and northern portions of the Islet. Onsite, elevations range from approximately 2 to 7 feet above sea level. Drainage on the Islet is toward the adjacent waterways with surface drainage on the State Marine site occurring to the east-southeast.

1.2.1.2 Site Features

The understanding of current conditions and Site features is based on aerial photographs, a Site inspection conducted in August 1998, and the 2003 RI (WESTON, 2003). Vehicle access to the Site is limited to a single dirt road originating at the western Site border along Old Yacht Club Road. Within the Site, dirt roads and trails connect various areas of current or historical operations. Along the shoreline are two sunken barge docks, orientated parallel to and forming part of the shore line. These two structures are the primary location where barges were moored during cleaning or maintenance. Two additional sunken barges lie perpendicular to the shoreline, as well as a third barge that is oriented parallel to the shoreline. These features are clearly shown on 1998 aerial photographs, as well as older photographs. Dredging of the canal in this area occurs approximately every two years (Saez, 1998).

Old marine equipment, including cranes and marine salvage debris, are present on the dock barges and inland areas. Several structures still exist, including a maintenance shed, a former office building, former wastewater treatment facility structures (boiler house, compressor building, and a former pump house), and at least one additional structure of unknown use. Most of these structures are partially collapsed and appear abandoned except for the maintenance shed, which may still be in use. Several aboveground storage tanks and 55-gallon drums sit at the Site. The status of the tanks and their contents was not investigated during the preliminary inspection (CH2M HILL, 1999), although several drums appeared to be partially full. Numerous vehicles, including old cranes, pickup trucks, and several tractors and tractor trailers are parked at the Site. None of the vehicles looked operational and several appear in various states of salvage or repair. The soil around many of the vehicles is oil stained.

The Site is partially vegetated with native shrubbery and grasses. Much of the Site is overgrown and few structures are recognizable relative to the original operations observed on historical aerial photographs. Fewer than 10-feet of shoreline are exposed at most locations. However, aerial photographs indicate a broader shoreline between the two dock barges, which were not visited during the preliminary inspection. The area is tidally influenced (1 to 2 feet) and the amount of shoreline exposed is likely to vary between tides. During the preliminary inspection, passing ships were observed to generate significant wave action at the shoreline. Based on the wave action and proximity of the canal, it is likely that the shoreline is eroding. Several trees exist and wetland vegetation occurs near or along some areas of the shoreline. Sea gulls were observed roosting on the offshore sunken barges (CH2M HILL, 1999).

1.2.2 Site Geology and Hydrogeology

The geology and hydrogeology of the State Marine Site are unusual, because the Site is situated on a man-made landmass within a waterway of considerable flow volume. This landmass consists of dredge spoils generated during construction and maintenance of the Sabine-Neches Canal. The canal was constructed between 1898 and 1920. The City of Port Arthur used the Site as a municipal landfill from approximately 1963 until 1974. Trench and fill methods were employed for disposal of the municipal waste. The entire Site was subsequently capped with what is believed to be dredge spoils. Municipal landfill debris is present in the shallow subsurface across the majority of the Site. The landfill material is usually encountered approximately 2 ft below the surface and typically ranges in thickness from 3 to 10 ft. As mentioned above, subsurface data for the site are limited; therefore, the cross section is highly generalized (CH2M HILL, 1999).

During the RI conducted by Weston Solutions Inc. completed in 2003 (Weston, 2003), the presence of landfill debris prohibited recovery of subsurface soil samples in most instances; thus, detailed information on the subsurface soil conditions across the majority of the Site could not be obtained. Based on observations during monitoring well installation activities, the soils underlying the landfill debris consist of dredge spoils underlain by alluvial deposits to the depths investigated (40 to 55 ft). These materials consisted primarily of saturated, very soft, gray silty clay. At one location, MW061, saturated, gray, silty sand was encountered at a depth of approximately 35 ft bgs (Weston, 2003).

Monitoring wells were installed at three locations during the RI field activities. The well locations were selected to obtain samples downgradient of the most significant source areas. In addition, based on observations during monitoring well installation, ground water is typically encountered at depths of approximately 2 to 4 ft bgs. Below this depth, soils remained saturated throughout the depths investigated (40 to 55 ft) without the presence of a distinct confining layer. Due to the extensive saturated thickness, two nested wells were installed at each of the three monitoring well locations, one to screen the upper 20 ft and one to screen the next 20 ft below. Because no previous ground water sampling had been conducted, the wells were used as a screening assessment of the ground water conditions (Weston 2003).

Although an obvious aquitard was not observed during the well installations, the water quality data indicate the presence of two separate zones. Salinity measurements were consistently higher in the deeper wells, which could indicate that a shallow perched zone is present and has a fresh water impact from precipitation. In addition, the piezometric surface of the shallow well measurements appears to follow the land surface topography. This is commonly seen in shallow perched aquifers. Based on the depth of water measured in the shallow screened wells, the base of the landfill may serve as the lower aquitard of a perched shallow ground water zone. For both the deep- and shallow-screened wells, ground water appears to flow to the southeast at a hydraulic gradient of 1.18 x 10-3 ft/ft and 2.13 x 10-2 ft/ft, respectively (Weston, 2003).

1.2.3 Ground Water Use

Ground water is used for industrial and irrigation purposes approximately 1.5 miles from the Site (TNRCC, 1997). Ground water is not known to be used for drinking purposes. Because of the underlying landfill, which precludes use of shallow ground water, and the proximity to brackish surface water, ground water is believed non-potable.

1.2.4 Ecological Resources

Pleasure Islet is situated in the northwest corner of Sabine Lake, a tidally-influenced estuary. Part of the designated use of this lake is high quality aquatic habitat and shellfish waters. The lake, which is an active habitat for a variety of water fowl and aquatic wildlife, contains a number of environmentally sensitive wetlands and bird rookeries, most of which have been designated as a National Wildlife Refuge. Critical habitats for various threatened or endangered species occur within a 15-mile radius of the site. The high quality aquatic habitat provided by Sabine Lake supports a variety of wetland plants. Detailed information regarding wetlands, protected species, and critical habitat locations were not available in the reviewed site literature.

Both commercial and noncommercial fishing occur in the area. There are three surface water intakes used for industrial purposes only within 15 miles downstream of the site. There are no drinking water intakes downstream of the site (TNRCC, 1997).

1.2.5 Summary of Waste Management Areas

The wastes generated and/or disposed at the Site appear to have included both raw product (original barge contents) and effluent generated during the cleaning and maintenance of barges. Waste generated and stored at the Lauren Refining Company (LRC) includes wastes similar to those generated at the State Marine site. Five different waste areas were identified in the 1999 Technical Memorandum (CH2M HILL, 1999), as listed below:

- Wastewater treatment facility (excluding the impoundments)
- Wastewater impoundments
- LRC former tank farm
- Sunken dock barges and barges

- Vehicle storage and maintenance and waste storage/handling areas

The locations and approximate sizes of the waste management areas, shown in **Figure 1-2,** were compiled from aerial photographs and Site inspection reports discussed earlier. Additional information regarding these areas is provided below:

- The former wastewater treatment facility includes all structures and work areas between the dock barges and the former impoundments, including an area of blasting sand occurring at the shoreline and dock barges.
- The impoundments include the areas previously identified on historical aerial photographs.
- The former tank farm is considered a waste management area and includes the boundary of the former tank farm as well as the boundary of a spill that migrated outside of this area.
- The dock barges (sunken and/or floating) and sunken barges are considered waste management areas and include sediments within and around the barges.
- The vehicle storage and maintenance and waste storage/handling areas include most of the area between the former tank farm and the former wastewater treatment facility. This area includes wastes associated with the repair or storage of vehicles or salvage materials, such as marine engines. Also included are at least three storage tanks from the former LRC tank farm, which were moved to the area between the office building and pump house.

1.2.6 Previous Site Investigations

Pleasure Islet provided a convenient barge cleaning area for vessels carrying supplies and petroleum products through Sabine Lake. The SMS and Palmer Barge Line Superfund Site (PBLS) both provided these types of services. In the course of the cleaning operations conducted at these two sites, hazardous materials spilled or were disposed inappropriately, potentially affecting human health and the environment. Several investigations have been conducted at the two sites in order to identify and characterize the sources and contaminants at both sites. This section summarizes the significant investigations at both the PBLS and SMS sites.

1.2.6.1 Expanded Site Inspection (ESI) at SMS (TNRCC)

In 1995, TNRCC initiated an ESI at SMS. The objective of the TNRCC ESI was to collect sufficient data to develop an understanding of the Site contaminants and to identify the potential migration pathways, primary contaminant sources, exposure pathways, and presence of potential human health and ecological receptors. The following reports were completed as a result of the data obtained from the field work during the ESI:

- 1996 Expanded Site Investigation Report (TNRCC).
- 1997 Hazardous Ranking System Documentation Report (TNRCC).
- 1999 Technical Memorandum (CH2M HILL).

The work performed, summary of results, and conclusions are provided in the 1996 ESI Report. The data obtained from the ESI enabled TNRCC to assign a hazardous ranking score to the Site as reported in the 1997 Hazardous Ranking System Documentation Report.

The analytical results from the 1995 TNRCC sampling event (TNRCC, 1995) were also summarized by CH2M HILL in the 1999 Technical Memorandum and were used to develop a Site Conceptual Model (SCM) as part of a screening level RI/FS. As a result of the SCM, it was found that waste materials associated with barge cleaning operations were the primary source of contamination. In addition, complete exposure pathways to human and ecological receptors were found to exist.

The 1995 sampling event included the collection of 30 soil samples, 34 sediment samples, and 9 surface water samples by TNRCC. In addition, 8 background samples were collected from locations around Sabine Lake near the Site. The samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), metals, and cyanide (CH2M HILL, 1999). A summary of investigation results obtained from the CH2M HILL 1999 Technical Memorandum is provided below:

Soil Samples

- VOCs were detected infrequently and at relatively low levels in several soil samples. None of the detected VOCs exceeded PRGs. Two of the detected VOCs, acetone and methylene chloride, were potential laboratory contaminants and may not be Site related.
- SVOCs including human carcinogens benzo(a)pyrene, benzo(a)anthracene, benzo(a)fluoranthene, benzo(b)fluoranthene, and benzo(k)fluoranthene were encountered in exceedance of PRGs in at least two samples from each waste area.
- Pesticides and PCBs were detected sporadically across the Site. At least one sample from each waste management area contained pesticides and/or PCBs that exceeded applicable PRGs.
- Metals were identified in every soil sample collected. Elevated levels of aluminum, chromium, copper, iron, lead, and zinc were encountered onsite and off. The highest levels of metals were generally located near or within the blasting sands area.

Sediment Samples

- VOCs were detected infrequently and at relatively low levels in several sediment samples. None of the VOCs detected were at concentrations exceeding their respective PRGs. Acetone and methylene chloride were potential laboratory contaminants and may not have been site-related.
- SVOCs, consisting primarily of polyaromatic hydrocarbons (PAHs), were found in five of seven sediment samples analyzed for SVOCs. Each of the five samples was collected adjacent to areas in which petroleum products were managed or disposed. Levels of benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene were consistently elevated among the PAHs detected.
- Pesticides and PCBs were detected infrequently in the sediment samples collected in Lake Sabine. Aroclor-1242 was detected in one sample, and lindane was detected in two sediment samples.

- Metals including arsenic, copper, iron, lead, manganese, mercury, nickel, and zinc were identified in every sediment sample. The highest concentrations of metals were reported to occur along the shoreline and near the sunken barges.

Surface Water Samples

- Nine surface water samples were collected from Sabine Lake. No VOCs or pesticides/PCBs were detected. SVOCs that were detected included benzo(g,h,i)perylene and bis(2-ethylhexyl)phthalate below their respective PRGs.

- Metals that were detected above their respective PRGs in the surface water samples included antimony, arsenic, selenium, and thallium.

No ground water samples were collected by TNRCC during this investigation.

The ESI confirmed the presence of contaminated soil in source areas. The presence of SVOCs and metals in sediment and surface water samples suggested that contaminants of concern migrated from source areas.

1.2.6.2 Remedial Investigation (WESTON)

An RI was conducted by WESTON in 2001, consisting of two sampling events in the fall of 2001, where sediment samples from offsite locations in Sabine Lake and soil and ground water samples from onsite locations on the SMS were collected.

As part of the field activities, the following sampling efforts were conducted:

- Completion of 6 deep borings [depths ranging from 25 ft to 60 ft below ground surface (bgs)].

- Installation of 6 monitoring wells.

- Completion of 5 shallow borings (depths ranging from 4 ft to 9 ft bgs).

- Collection of surface soil samples at 87 stations (depths ranging from 0 to 6 in. bgs).

- Collection of intertidal samples at 9 stations (depths ranging from 0 to 6 in. bgs).

- Collection of sediment samples from 46 stations [depths ranging from 0 to 6 ft below sediment surface (bss)].

The analytical results were reviewed and compared to the Tier 1 Commercial/Industrial Protective Concentration Levels (PCLs) established in the Texas Risk Reduction Program (TRRP), and where appropriate, the results were also compared to background numbers for site COCs.

The most frequently detected COCs for all sediments samples collected were metals including arsenic, lead, and mercury. For intertidal sediments, six metals (antimony, arsenic, cadmium, lead, mercury, and selenium) and one SVOC (pentachlorophenol) exceeded Tier 1 Protective Concentration Levels (PCLs). Constituents that exceeded Tier 1 PCLs for nearshore sediments included six metals (arsenic, barium, beryllium, cadmium, lead, and mercury) and one SVOC (3,3-dichlorobenzidine). Only arsenic, lead, and mercury exceeded Tier 1 PCLs for off-shore sediments. The most frequently detected COCs for all soils at the SMS site are metals including antimony, arsenic, barium, lead, mercury, and silver. These metals consistently exceeded the ^{Gw}Soil PCL.

Based on the distribution of these constituents, WESTON concluded that their occurrence is most likely a result of the former incineration and landfill operations (WESTON, 2003). In general, the metals are widely distributed across the site and not limited to the SMS source areas. Although the distribution is primarily widespread, several distinct patterns of the metals are apparent and include the following:

- A “hot spot” of arsenic, barium, and lead is located on the northern central boundary of the site.
- Elevated antimony concentrations can be seen primarily in the northern central portion of the site.
- A “hot spot” of mercury and silver concentrations appears to be located near the northern edge of the Former Lauren Tank Farm area.

Isolated detections of the SVOCs (including benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and pentachlorophenol) were reported at relatively low concentrations for on-site soils. Because the SVOC exceedances were only detected at isolated locations, impact from operations on the SMS site appears minimal (WESTON, 2003).

Nine constituents including eight metals (antimony, arsenic, barium, beryllium, lead, manganese, silver, and thallium) and one SVOC (pentachlorophenol) exceeded Tier 1 $^{GW}GW_{Ing}$ PCLs. Based on a preliminary comparison of ground water analytical results to class 3 ground water criteria, no constituents exceed class 3 ground water PCLs. However, due to the considerable saturated thickness observed in the subsurface soils, it is unlikely that determination of sustainable yield would result in a class 3 ground water resource classification. As discussed previously, the site is situated on a man-made landmass within a very large waterway. The near surface strata consist of landfill debris and dredge spoils underlain by recent alluvial deposits. These materials are unconsolidated and highly saturated. Based on drilling observations and the water quality data collected at the site, it appears that the deeper ground water encountered at the site is directly influenced by the adjacent brackish water body, and the shallow ground water zone is perched within the landfill material. As a result of this data, and the fact that a former landfill overlies the site, it is unrealistic to assume any beneficial use of the shallow ground water (WESTON, 2003).

1.2.6.3 Other Investigations Adjacent to the SMS

A Preliminary Assessment (PA), a Screening Site Inspection (SSI), and an ESI were conducted immediately adjacent to the Site at the PBLS. The PBLS is located on Pleasure Islet immediately north of the SMS. These investigations did not involve collecting soil, sediment, or ground water directly from the SMS; however, some sediment data obtained from the PBLS at near-shore and offshore locations were used in the human health and ecological screening risk assessment. Details of the PBLS investigations are summarized below.

Preliminary Assessment (TNRCC)

The PA at PBLS was conducted by TNRCC in November 1997. The objective during the PA was to assess whether there was contamination at PBLS that posed immediate threat to human health and the environment. Source areas identified as potentially hazardous included the vacuum tank sump, the boiler house, the flare, the 12-tank battery and roll-off boxes, and the wastewater tanks (TNRCC, 1998). These areas of concern were further evaluated in the 1998 SSI.

Screening Site Inspection (TNRCC)

In March 1998, TNRCC conducted the SSI at PBLS. The investigation was conducted in order to characterize the nature and extent of contamination and to determine whether the Site would be eligible for placement on the National Priority List (NPL). Field activities included the collection of thirteen soil samples at the various sources and twelve sediment samples from Lake Sabine.

Soil Samples

Soil samples were collected at the vacuum tank sumps, the boiler house, the flare, the 12-tank battery and roll-off box, and the wastewater tanks. The laboratory results showed numerous SVOCs, pesticides, and metals present at concentrations exceeding the contract required quantitation limits (CRQLs) at all of the source areas. Two pesticides (aroclor-1254 and aroclor-1260) detected in exceedance of their CRQLs (TNRCC, 1998) at the 12-Tank Battery and Roll-off Box area.

Sediment Samples

Nine sediment samples were collected offsite in Lake Sabine to assess whether contamination had migrated from onsite source areas. Three background samples were collected to establish a comparison value for the release samples. The analytical results showed concentrations of cyanide, metals, and SVOCs. Barium, copper, manganese, and mercury were detected at concentrations three times the background values and were attributed to source areas at PBLS. Therefore, they were identified as released substances (TNRCC, 1998).

The SSI determined that contaminated soil existed at offsite source areas at PBLS. Barium, copper, manganese, and mercury were detected at concentrations three times background levels in the sediment samples and could attributable back to source areas; therefore, it was determined that hazardous substances had been released from the PBLS.

Palmer Barge Line Site Expanded Site Investigation (Weston)

In October 1999, Weston conducted an ESI at the PBLS. The PBLS is located north of the SMS on Pleasure Islet. The purpose of the ESI was to identify immediate or potential threats that hazardous substances, attributable to the site, posed to human health and the environment and to identify the receptors, or targets, potentially exposed to the hazardous substances. The field activities during the ESI focused on determining the presence and nature of onsite contaminated soil and ground water and offsite contaminates in Sabine Lake. The information obtained in the ESI was used to evaluate whether the site should have been placed on the NPL or given a status of "No Further Remedial Action Planned" (NFRAP) (Weston, 2000).

Soil Samples

The soil boring locations included the wastewater above-ground storage tanks (ASTs), the boiler house ASTs, the open top slop tanks, horizontal ASTs, twelve ASTs, the flare, and background locations. Samples were collected from 0 to 2 ft and from 2 to 4 ft in depth. The laboratory results showed numerous VOCs, SVOCs, pesticides, PCBs, and metals present at concentrations exceeding the CRQLs at all of the source areas (Weston, 2000).

Ground Water Samples

Ground water samples were collected downgradient of the wastewater AST (Tank 102) and the 12 ASTs. The ground water samples were generally collected at 8 to 20 feet bgs. The analytical results showed one VOC (tert-butyl methyl ether), no SVOCs, one pesticide (4,4'-DDD), and 13 metals detected at three times the background concentrations (Weston, 2000).

Sediment Samples

Weston collected 22 sediment samples, including 5 background samples, to document possible impact to Lake Sabine sediments adjacent to the PBLS. The samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and cyanide. The results of the ESI documented that SVOCs, pesticides/PCBs, and numerous metals were present at levels exceeding background concentrations. The data were used to support the conclusion that an observed release to the surface water pathway had occurred (Weston, 2000).

The ESI performed at the PBLS confirmed the presence of contaminated soil and contaminated ground water at several source areas. The presence of SVOCs, pesticides, PCBs, and metals in the sediment samples collected at Sabine Lake also confirmed that contaminants of concern migrated from source areas to Sabine Lake, potentially affecting human and ecological receptors.

1.3 Nature and Extent of Contamination

The nature and extent (N&E) of contamination at the Site has been documented through sampling onsite and offsite of various environmental media during the RI (Weston, 2003) and previous field efforts. This section provides a summary of the N&E of contamination.

1.3.1 Soil

Municipal landfill debris is present in the shallow subsurface across a large portion of the Site. The landfill material is usually encountered approximately 2 ft below the surface and typically ranges in thickness from 3 to 10 ft. The presence of this material prohibited recovery of subsurface soil samples in most instances; therefore, detailed information on the subsurface soil conditions was unavailable. Based on observations during monitoring well installation activities, the subsurface soils consist of dredge spoils to the depths investigated (40 to 55 ft). These materials consisted primarily of saturated, very soft, gray, silty clay. At one location, MW061, saturated, gray, silty sand was encountered at a depth of approximately 35 ft bgs.

The soil analytical results have been compared to Commercial/Industrial PCLs for the 30-acre source area established in the TRRP. The tables present comparisons to both the ${}^{Tot}Soil_{Comb}$ and the ${}^{GW}Soil$ PCLs and/or the Texas-Specific Background Concentrations (for arsenic, barium, and lead).

1.3.1.1 Background Soil Analytical Results and PCL Development

Background soil samples were collected from three offsite locations. The background samples were analyzed for Target Analyte List (TAL) metals and Target Compound List (TCL) SVOCs. Background sample analyses can be used to demonstrate that Site COCs are naturally occurring or are present as a result of anthropogenic activities unrelated to Site operations. By making this demonstration, PCLs can be upwardly adjusted to the background concentrations and used as assessment levels in determining the extent of impacted media. The background soil samples were compared to two benchmarks: the TRRP Tier 1 Commercial/Industrial ground water protection PCLs for soils from a 30-acre source area and to the listed Texas-Specific Background Concentrations.

Based on this comparison, arsenic, barium, lead, and mercury were reported at concentrations exceeding TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs. The average concentrations for these contaminants from the background locations were 4.7 mg/kg, 284 mg/kg, 20.1 mg/kg, and 0.07 mg/kg, respectively. After comparing the average background concentrations to the listed Texas-Specific Background Concentrations, it was apparent that Site background conditions are similar to the Texas-Specific Concentrations for these metals. Cadmium, cyanide, and selenium were not found above laboratory reporting limits. The remaining TAL metals were detected but did not exceed Tier 1 PCLs.

For the TCL SVOCs, no constituents were detected in the background samples above laboratory reporting limits with the exception of samples that were flagged or qualified based on unique reporting circumstances.

Based on the evaluation of the background sample results, the Tier 1 PCLs are appropriate for use as assessment levels at the Site, rather than the background results. Because the background sample concentrations are so similar to the Texas-Specific Background Concentrations, the published Texas-Specific Background Concentrations for arsenic, barium, and lead were selected for use as the critical PCLs for these constituents.

1.3.1.2 Former Wastewater Impoundments

Nine surface soil samples, including one field duplicate, were collected and analyzed for TAL metals and TCL SVOCs from the former Wastewater Impoundments Area.

Based on the comparisons to TRRP Tier 1 Commercial/Industrial PCLs for soils, the following contaminants with the associated maximum reported concentrations were detected at levels exceeding ^{GW}Soil PCLs: antimony (20.5 mg/kg), arsenic (7.4 mg/kg), barium (534 mg/kg), lead (210 mg/kg), and mercury (0.16 mg/kg). The remaining TAL metals were either not detected or were detected at concentrations below Tier 1 PCLs. No TCL SVOCs were detected at levels exceeding PCLs; however, several PAHs were detected at levels above laboratory reporting requirements. These PAHs were all detected at only one location in the former Wastewater Impoundment Area (SM122-51-1). It should be noted that some constituents were flagged with data qualifiers indicating unique reporting circumstances, but none of these flagged values exceeded Tier 1 PCLs.

1.3.1.3 Wastewater Treatment Facility

Eight surface soil samples, including one field duplicate, were collected and analyzed for TAL metals and TCL SVOCs from the Wastewater Treatment Facility.

Arsenic, lead, mercury, and silver were found to exceed TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs with maximum reported concentrations of 10.4 mg/kg, 150 mg/kg, 0.98 mg/kg, and 1.4 mg/kg, respectively. The remaining TAL metals were either not detected or detected at concentrations below Tier 1 PCLs.

No TCL SVOCs were detected at any sample location in the Wastewater Treatment Facility with the exception of constituents identified with data qualifiers.

1.3.1.4 Tar Burn Area

Four surface soil samples were collected and analyzed for TAL metals and TCL SVOCs from the Tar Burn Area.

Lead, mercury, and silver were found to consistently exceed the TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs with maximum reported concentrations of 967 mg/kg, 0.31 mg/kg, and 1.0 mg/kg, respectively. The remaining TAL metals were either not detected or detected at concentrations below Tier 1 PCLs.

No TCL SVOCs were detected at concentrations exceeding risk based levels. Constituents that were detected but did not exceed risk based levels included the following PAHs: benzo(a)pyrene, benzo(b)fluoranthene, and butylbenzylphthalate. Some constituents were flagged with data qualifiers indicating unique laboratory reporting circumstances, but none of these constituents exceeded risk based values.

1.3.1.5 Aboveground Storage Tank Area

Six surface soil samples, including two field duplicates, were collected and analyzed for TAL metals and TCL SVOCs from the AST area.

Arsenic, lead, mercury, and silver were found to exceed TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs with maximum concentrations of 7.9 mg/kg, 558 mg/kg, 0.13 mg/kg, and 0.96 mg/kg, respectively. The remaining TAL metals were either not detected or detected at concentrations below Tier 1 PCLs.

The TCL SVOC analysis detected two constituents at concentrations above Tier 1 PCLs. These constituents and maximum reported concentrations included benzo(a)pyrene, (2.7 mg/kg), which exceeded both the $^{TOT}Soil_{Comb}$ and $^{GW}Soil$ PCLs, and pentachlorophenol (0.28 mg/kg), which exceeded the $^{GW}Soil$ PCL. The remaining TCL SVOCs were either not detected or detected at concentrations below risk-based values. Some constituents were flagged with data qualifiers indicating unique reporting circumstances, but none of these flagged values exceeded risk-based values.

1.3.1.6 Maintenance Shed Area

Five surface soil samples, including one field duplicate, were analyzed for TAL metals and TCL SVOCs from the Maintenance Shed Area.

Antimony, arsenic, lead, mercury, and thallium were detected at concentrations exceeding TRRP Tier 1 Commercial/Industrial $^{GW}Soil$ PCLs. The maximum concentrations reported for these metals were 5.8 mg/kg, 19 mg/kg, 290 mg/kg, 0.11 mg/kg, and 1.6 mg/kg, respectively. The remaining TAL metals were either not detected or detected at concentrations below Tier 1 PCLs.

For TCL SVOCs, no constituents were detected above laboratory quantitation limits with the exception of constituents identified with data qualifiers. These flagged values did not exceed risk-based values.

1.3.1.7 Former Lauren Tank Farm Area

Six surface soil samples were analyzed for TAL metals and TCL SVOCs from the former Lauren Tank Farm Area.

Arsenic and lead were consistently detected at concentrations exceeding TRRP Tier 1 Commercial/Industrial $^{GW}Soil$ PCLs in the Lauren Tank Farm Area. The highest reported concentrations for arsenic and lead were 26.4 mg/kg and 1030 mg/kg, respectively. Antimony, cadmium, copper, mercury, nickel, selenium, silver, and thallium were also detected less frequently at concentrations exceeding the $^{GW}Soil$ PCLs. The remaining TAL metals were either not detected or detected at concentrations below risk-based levels.

For TCL SVOCs, benzo(a)pyrene (5.1 mg/kg) was the only constituent to exceed Tier 1 PCLs. The majority of the remaining constituents were not detected at levels above laboratory reporting requirements. A small number of constituents were flagged with data qualifiers indicating unique laboratory reporting circumstances; however, none of these constituents exceeded risk based values.

1.3.1.8 Non-source Areas

A majority of the sample locations at the Site came from areas that did not fall within the defined source areas. These sample locations were defined as non-source sample locations. A total of 66 surface soil samples, including 6 field duplicates, were analyzed for TAL metals and TCL SVOCs from the non-source area. The same trend was apparent in the non-source area as it was in the source areas with regard to the pattern of contaminants detected in the soils.

Arsenic and lead were consistently detected at concentrations exceeding the TRRP Tier 1 Commercial/Industrial ^{GW}PCLs for soils with maximum reported concentrations of 48.7 mg/kg and 2040 mg/kg, respectively. Seven additional TAL metals were detected at concentrations exceeding ^{GW}Soil PCLs but were detected much less frequently than arsenic and lead. These metals with the associated maximum reported concentrations included antimony (26.3 mg/kg), barium (744 mg/kg), beryllium (1.2 mg/kg), cadmium (16.4 mg/kg), copper (5480 mg/kg), mercury (0.54 mg/kg), silver (8.3 mg/kg), and thallium (2.9 mg/kg). The remaining TAL metals were either not detected or were detected at concentrations below risk-based levels.

For TCL SVOCs, three PAH compounds were detected at two locations that exceeded ^{TOT}Soil$_{Comb}$ and/or ^{GW}Soil PCLs. These PAHs and associated concentrations included benzo(a)anthracene (24 mg/kg), benzo(b)fluoranthene (25 mg/kg) and benzo(a)pyrene (19 mg/kg). Carbazole and PCP(Pentachlorophenol) were also detected at 7.5 mg/kg and 0.060 mg/kg, respectively, at one location, which exceeds the ^{GW}Soil PCL. The remaining TCL SVOCs were either not detected or were detected at levels below risk-based levels. A small number of constituents were flagged with data qualifiers indicating unique laboratory reporting requirements.

1.3.1.9 Subsurface Soil Analytical Results

The subsurface investigation during the 2001 RI did not proceed as originally intended due to a large portion of the Site having excessive landfill material and debris that prohibited subsurface sample recovery with conventional direct-push sampling equipment. According to the 2001 RI/FS TWP, the entire sampling grid (87 stations) would be sampled for subsurface soils; however, due to Site conditions, only 15 locations were attempted. Of the 15 attempted, only 5 were successful in obtaining subsurface samples. Three additional locations were sampled using hollow-stem augers in which subsurface recovery was obtained. Thus, a total of 8 sample locations out of 18 attempted were successful.

A total of 11 subsurface soil samples, including one field duplicate, were collected and analyzed for TAL metals and TCL SVOCs from locations collected across the Site.

As with surface soil samples, arsenic and lead were consistently detected at concentrations exceeding the TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs with maximum reported concentrations of 12.6 mg/kg and 558 mg/kg, respectively. Seven additional TAL metals (antimony, beryllium, mercury, thallium, barium, cadmium, and silver) were detected at concentrations exceeding the ^{GW}Soil PCL values but were detected less frequently than arsenic and lead. The remaining TAL metals were either not detected or were detected at concentrations below Tier 1 PCLs.

For TCL SVOCs, only one constituent from the 11 subsurface locations exceeded Tier 1 PCLs. PCP was detected at a concentration of 0.060 mg/kg. The remaining constituents were either not detected or detected at concentrations below Tier 1 PCLs. A small number of constituents were flagged with data qualifiers indicating unique laboratory reporting requirements.

1.3.2 Sediment

Sediments in the intertidal area typically consisted of brown sand with abundant shell fragments and some wood and roots. Due to the adjacent landfill, intertidal sediments also contained a large amount of debris such as glass and plastic fragments.

Offshore and nearshore sediments varied in composition, depending on their proximity to the sunken barges along the shoreline. Generally, the area around and between the sunken barges consisted predominantly of a fine-grained silty sand with most samples containing occasional shell fragments. The sediments outside the sunken barges predominantly consisted of a dark silty to sandy clay with frequent shell fragments. It was also noted that the sediments adjacent to the Palmer Barge Site were typically more fine-grained and darker in color.

The analytical results are discussed below. It should be noted that at some stations TCL metal constituents were reported by both Severn Trent Laboratory (STL) and Colombia Analytical. Unless otherwise stated, the metals concentrations discussed in the text were reported by STL. The sediment analytical results have been compared to Commercial / Industrial PCLs for the 30-acre source area established in the TRRP. The tables present comparisons to both the soil PCL for combined ingestion, dermal contact, and inhalation of volatiles and particulates $^{Tot}Soil_{Comb}$, and to the PCL for soil to protect ground water $^{GW}Soil$ PCLs. These PCLs are appropriate for use as assessment levels for sediments at the SMS site based on the following criteria:

- Surface water adjoining the Site is tidally influenced, and intertidal sediments are exposed at periods of low tide. Therefore, ingestion, dermal contact, and inhalation of volatiles and particulates are potential exposure routes for these media.
- Nearshore and offshore sediments are not exposed during periods of low tide; however, these sediments are continually in contact with surface water. Use classification of Sabine Lake includes recreation, and ingestion is a potential exposure route. Therefore, the PCL for soil to protect ground water could be applied as a conservative measure for nearshore and offshore sediments as well as for intertidal sediments, which are in contact with surface water during periods of high tide.

Further evaluation of the sediment analytical results are provided in the screening-level risk assessments in RI appendices (Weston, 2003).

1.3.2.1 Background Sediment Analytical Results

Background sediment samples were collected from five offsite locations adjacent to Sydnes Island, which is located approximately 2 miles northeast of the State Marine site. The background sediment samples were analyzed for TAL metals and TCL SVOCs. Under TRRP, background sample analyses can be used to demonstrate that Site COCs are naturally occurring or present as a result of anthropogenic activities unrelated to Site operations. By making this demonstration, PCLs can be upwardly adjusted to the background concentrations and used as assessment levels in determining the extent of impacted media at the Site. To evaluate whether it was beneficial to use the background results as assessment levels, the samples were compared to two benchmarks: the TRRP Tier 1 Commercial / Industrial ground water protection PCLs for soils from a 30-acre source area and the listed Texas-Specific Background Concentrations.

Based on this comparison, mercury had detections slightly exceeding TRRP screening levels but significantly less than the listed Texas-Specific Background Concentrations. The average concentration was 0.004 mg/kg. Although the average background concentration is above Tier 1 PCLs, it is significantly less than the Listed Texas-Specific Concentrations for metals and is reflective of values of background metal concentrations for the area. The remaining TAL metals were detected but did not exceed Tier 1 PCLs.

For the TCL SVOCs, no constituents were detected in the background samples above laboratory reporting limits with the exception of samples that were flagged or qualified based on unique reporting circumstances.

Based on this evaluation of the background sample results, the Tier 1 PCLs are appropriate for use as assessment levels, rather than the background results. Published Texas-Specific Background Concentrations for lead and mercury are appropriate for use as the critical PCL for these constituents.

1.3.2.2 Intertidal Analytical Results

Nine intertidal sediment samples were collected and analyzed for TAL metals and TCL SVOCs.

Lead and mercury were consistently detected at concentrations exceeding the TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs for soils with maximum reported concentrations of 942 and 0.18 mg/kg, respectively. It should be noted that the lead concentrate was reported by Colombia Analytical. Antimony, arsenic, cadmium, and selenium were also detected at concentrations above Tier 1 PCLs; however, these metals were detected less frequently. The remaining TAL metals were either not detected or detected at concentrations below Tier 1 PCLs.

For the TCL SVOCs, PCP was detected at a concentration exceeding the TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs. PCP was detected at two intertidal locations at concentrations of 0.82 mg/kg and 0.160 mg/kg. The majority of the remaining constituents were not detected at levels above laboratory reporting requirements. A small number of constituents were detected above laboratory reporting limits with the exception of samples that were flagged or qualified based on unique reporting circumstances.

1.3.2.3 Nearshore Analytical Results

Fifty-eight sediment samples, including eight field duplicates, were collected and analyzed for TAL metals and TCL SVOCs from the nearshore locations.

Arsenic, lead, and mercury were consistently detected at concentrations exceeding the TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs for soils with maximum reported concentrations of 14.3, 29.9 and 0.075 mg/kg, respectively. Barium, beryllium, and cadmium were additional constituents that were infrequently detected at concentrations above Tier 1 PCLs. The remaining TAL metals were either not detected or detected at concentrations below risk based levels.

For TCL SVOCs, 3,3-dichlorobenzidine was the only constituent to exceed risk-based levels. This constituent was reported at a concentration of 0.075 mg/kg at location PB010-51, which exceeds the ^{GW}Soil PCL. The majority of the SVOC constituents were not detected at levels above laboratory reporting requirements. A small number of constituents were flagged with data qualifiers indicating unique laboratory reporting circumstances; however, none of these constituents exceeded risk-based levels.

1.3.2.4 Offshore Analytical Results

A total of 12 sediment samples including 1 field duplicate was collected and analyzed for TAL metals and TCL SVOCs from the offshore locations.

Arsenic, lead, and mercury were consistently detected at concentrations exceeding the TRRP Tier 1 Commercial/Industrial ^{GW}Soil PCLs for soils with maximum reported concentrations of 8.9, 15.1, and 0.072 mg/kg, respectively. The remaining TAL metals were either not detected or detected at concentrations below Tier 1 PCLs.

For the TCL SVOCs, no constituents exceeded the comparison values. Only two constituents [benzo(a)pyrene and bis(2-ethylhexyl)phthalate] were detected above laboratory reporting limits with the exception of samples that were flagged or qualified based on unique reporting circumstances.

1.3.3 Ground Water / Surface Water

The shallow ground water appears to be a mix of fresh and brackish water from the lake, making it unsuitable for human consumption. In addition, the ground water exists at depths where the landfill material exists. Therefore, ground water may be affected by constituents of concern from landfill wastes and not suitable for household drinking water use. Based on the high TDS concentrations, the proximity of the Site to brackish surface water, and the presence of the underlying landfill, there is no current or anticipated future use of ground water as a source of potable water at the Site. Based on the available Site data, the ground water resource classification is Class 2.

Ground water results were compared to both the TRRP Tier 1 Commercial/Industrial PCL for ground water ingestion ($^{Gw}Gw_{Ing}$) and the EPA Region 6 Tap Water Media Specific Screening Levels (MSSLs). Further evaluation is provided in the risk assessments in the RI appendices (Weston, 2003). The results from the following subsections are presented in the 2003 RI (Weston 2003).

1.3.3.1 October 2001 Ground Water Results

Six monitoring wells were installed at the Site and were sampled for metals, VOCs, and SVOCs. Of the six samples submitted for TAL metals analysis, every constituent exceeded TRRP Tier 1 Commercial/Industrial $^{Gw}Gw_{Ing}$ PCLs for each sample location. In addition, arsenic, barium, lead, and manganese exceeded EPA Region 6 MSSLs.

For VOCs and SVOCs, only pentachlorophenol exceeded risk Tier 1 PCLs. The contaminant was detected in one well (MW061B) with a concentration of 0.004 mg/kg. The remaining VOCs and SVOCs constituents were either not detected or were detected at concentrations below risk-based levels. A small number of constituents were flagged with data qualifiers indicating unique laboratory reporting circumstances; however, none of these constituents exceeded Tier 1 PCLs.

Several organic constituents exceeded EPA Region 6 MSSLs for tap water, including the following:

- Pentachlorophenol.
- 1,1,2,2 – Tetrachloroethane.
- 1,1,2 – Trichloroethane.
- 1,1 – Dichloroethane.
- 1,2 - Dibromo-3-chloropropane.
- 1,2 – Dibromoethane.
- 1,2 – Dichloroethane.
- 1,2 – Dichloropropane.
- 1,4 – Dichlorobenzene.
- Benzene.

These constituents were reported at relatively low concentrations.

1.3.3.2 June 2002 Investigation Results

Weston conducted an additional investigation in June 2002. The investigation included collecting ground water samples from the six, existing monitoring wells and collecting surface water from Sabine Lake. The primary objective for sampling the existing monitoring wells was to provide additional ground water data for the SMS site and to compare this data to the October 2001 ground water data.

The primary objective for sampling the surface water adjacent to Site was to evaluate whether constituents were migrating through the ground water to Sabine Lake. The focus for sampling surface water was to detect TAL metals, particularly those that were detected in onsite ground water in excess of ecological-based surface water screening benchmarks.

Surface Water

Surface water samples were analyzed for both total and dissolved metals. The analytical results were compared to the following two regulatory values: TRRP Tier 1 Commercial / Industrial $^{GW}GW_{Ing}$ and EPA Region 6 Tap Water MSSLs. Based on the results, lead (0.09 mg/l) was the only constituent that exceeded regulatory values for total metals. No samples exceeded regulatory values for dissolved metals.

Ground Water

Ground water samples were analyzed for total and dissolved metals. The analytical results were compared to the following regulatory values: TRRP Tier 1 Commercial/Industrial $^{GW}GW_{Ing}$ and EPA Region 6 Tap Water MSSLs. Based on the results, arsenic and manganese were consistently detected above regulatory values.

1.4 Risk Assessment Summary

1.4.1 Human Health Risk Assessment Summary

The following sections summarize the approach, assumptions, and conclusions of the baseline human health risk assessment (HHRA) for the State Marine Superfund Site, conducted by CH2M HILL in July 2005 (CH2M HILL, 2005a).

1.4.1.1 Data Used in the HHRA

Soil

All historical soil data that were available to CH2M HILL electronically as of June 17, 2005, were used in the HHRA. The following data groupings were used in the HHRA:

- Wastewater Impoundment Area
- Wastewater Treatment Facility
- Tar Burn Area
- Current Aboveground Storage Tank Area
- Maintenance Shed Area
- Lauren Tank Farm

- Non-Source Area

Ground Water

Ground water data were not used in the HHRA due to the lack of ground water receptors (ground water is not used as a potable source, chemicals of potential concern are inorganics and semivolatile organic compounds, and no ground water seeps were observed during the site reconnaissance visit on June 17, 2005).

Surface Water

Surface water data were not used in the HHRA. (Although one surface water sample was available, the methodology used for its collection reflected ground water quality rather than surface water).

Sediment

All historical sediment data collected from the 0 to 6-inch interval and available to CH2M HILL electronically as of June 17, 2005, were used in the HHRA. The available data consisted of sediment samples collected in 1995 and 2001. All sediment groupings previously identified in the 1995 and 2001 data sets were combined into one sediment grouping. The sediment data were used to model edible fish tissue concentrations.

Fish

Historical edible fish tissue data available for Sabine Lake are discussed in the Uncertainty Assessment below.

1.4.1.2 Potential Receptors

The following receptors were identified onsite and in the vicinity of the Site and were evaluated for significant exposure pathways in the HHRA:

- **Current onsite** – industrial/commercial worker (site owner), adult trespasser (although very infrequent since the site is remote in relation to residential areas)
- **Current offsite** – adult or child eating fish caught in Lake Sabine
- **Future onsite** – industrial/commercial worker, construction worker, and adult trespasser (although very infrequent since the site is remote in relation to residential areas)

- **Future offsite** – adult or child eating fish caught in Lake Sabine

1.4.1.3 Chemical of Potential Concern Selection Process

The chemicals of potential concern (COPCs) were identified for soil and sediment by a three-step screening process that evaluated 1) frequency of detection, 2) background concentrations, and 3) risk-based screening levels. In addition, chemicals that were considered to be essential nutrients (calcium, magnesium, potassium, and sodium) were not selected as COPCs.

1.4.1.4 Exposure Pathways Quantified in the HHRA

Various potential exposure pathways were quantified in the HHRA. Each soil "hot spot" area and the non-source area were evaluated separately. The following groupings were used to estimate potential risks for the indicated receptors:

- Seven Current/Future Onsite Industrial/Commercial Worker groupings
- Current/Future Onsite Trespasser (not quantified since their exposure would be less than the industrial/commercial worker)
- Current/Future Offsite Fisher
- Future Construction Worker (not quantified since only two subsurface soil samples are available and their exposure would be less than the industrial/commercial worker)

The 95 percent upper confidence limit (95% UCL) on the mean concentration of each soil COPC was used as the exposure point concentration (EPC) unless it exceeded the maximum detected concentration for that data grouping. In sediment, the 95% UCL on the mean concentrations (or the maximum concentration, whichever was lower) was used to model the EPCs of sediment COPCs in fish. The 95% UCLs were calculated using the most recent version of ProUCL (Version 3.00.02).

1.4.1.5 Exposure Factors

A reasonable maximum exposure (RME) scenario was quantified for each of the indicated receptors. If the potential risks associated with an RME scenario exceeded acceptable risk levels, a central tendency (CT) scenario was also quantified. The exposure factors used in the risk calculations are summarized below:

- **Industrial/Commercial Worker** – For each exposure parameter, the more conservative value between the standard default exposure factors presented in EPA guidance and the exposure factors used in TRRP.
- **Fisher** - Standard default exposure factors presented in EPA guidance, with the exception of a fish ingestion rate of 0.026 kg/day, as presented in the Calcasieu Estuary Superfund Site study.

1.4.1.6 Toxicity Assessment

The following hierarchy of sources was used to obtain toxicity data for chemicals detected at the site:

- Integrated Risk Information System (IRIS)
- Provisional Peer-Reviewed Toxicity Values (PPRTVs)
- National Center for Environmental Assessment (NCEA)
- Health Effects Assessment Summary Tables (HEAST)

For those constituents without toxicity values, toxicity values for surrogate chemicals were used when available.

1.4.1.7 Risk Characterization

Potential excess lifetime cancer risks (ELCRs) and hazard indexes (His) were calculated using RME assumptions for the receptors and exposure pathways identified above.

1.4.1.8 Uncertainty Assessment

The following discussion presents the major uncertainties associated with this HHRA.

Data Issues

Sample quantitation limits (SQLs) for some analytes in soil and sediment samples exceeded screening levels. However, these chemicals are not expected to be site-related and therefore there is no significant impact on the HHRA or its conclusions.

There is some uncertainty associated with the historical data collected in 1995 in terms of the exact locations where these samples were collected. However, the data were used since it represents soil/sediment quality onsite and adjacent to the site. Use of this data is not expected to affect the conclusions of the HHRA, but adds uncertainty to the locations that may warrant risk management.

Pesticides in Soil

Dieldrin and heptachlor epoxide were identified as COCs in soil. These chemicals are not expected to be associated with site activities. As background concentrations were not available for comparison, there is uncertainty in the risk estimates by inclusion of these chemicals.

Aroclor 1242 in Sediment

Aroclor 1242 could be a risk driver for sediment in the HHRA. However, there is significant uncertainty in the risk calculations, primarily due to the available dataset. No source has been identified onsite, and available data from all areas indicate no hits of Aroclor 1242 anywhere.

Aroclor 1242 was detected in one of seven sediment samples; it was the only Aroclor detected. PCBs were not analyzed in the background sediment dataset. The fish ingestion risk calculations are based on a single, detected PCB concentration in sediments. This concentration is not expected to represent the PCB concentrations that a fish comes in contact with during its lifetime before it is caught and eaten since a fish's home range is much larger than the single location. Therefore, using one location to model fish uptake is extremely conservative.

The Texas Department of Health (TDH) prepared a risk assessment of Sabine Lake under EPA's Near Coastal Water Grant (TDH, 1995). Although these data were gathered for a broader study, the data were reportedly collected in accordance with EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Fish Sampling and Analysis* (EPA, 1993) and analyses were performed in the TDH laboratory using EPA-approved methods for detection of metals, pesticides, PCBs, and semivolatile and volatile organic constituents. Aquatic species were collected to represent commonly consumed edible tissue taken by the public from sample locations in Sabine Lake (South), Sabine Lake (North), and Sabine Pass. The analytical data from this investigation are presented in the table below. As shown, Aroclor 1242 was not detected in fish samples.

PCB'S IN FISH TISSUE TAKEN FROM SABINE LAKE

PCB	Detection Limit (PPB)	LOCATION AND SAMPLE NO.									
		SABINE LAKE (SOUTH)				SABINE PASS	SABINE LAKE (NORTH)				
		4	5	6	7	8	9	10	11	12	13
		CONCENTRATION (PPB)									
AROCLOR 1016	40	nd	nd[a]	nd	nd	nd	nd	nd	nd	nd	nd
AROCLOR 1221	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
AROCLOR 1232	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
AROCLOR 1242	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
AROCLOR 1248	40	nd	nd	nd	nd	38[b]	nd	nd	nd	nd	nd
AROCLOR 1254	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
AROCLOR 1260	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
AROCLOR 1262	40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

[a]non-detectable
[b]reported below quantitation limits

EXHIBIT - 1
PCB's in fish tissue taken from Sabine Lake
State Marine Superfund Site

Copper in Sediment

Copper is a risk driver for sediment in the HHRA. However, there is much uncertainty in the risk calculations, primarily due to the available dataset. No significant source of copper has been identified onsite.

As expected (since copper is a naturally-occurring element), copper was detected in 61 of 62 sediment samples. Copper was not analyzed in the background sediment dataset. The fish ingestion risk calculations are based on a 95% UCL concentration based on the 62 samples. Only five locations exceeded risk-based concentrations.

The calculated HI is 2 using both RME and CT exposure scenarios. This level is only slightly higher than the acceptable HI of 1.

The TDH prepared a risk assessment of Sabine Lake under EPA's Near Coastal Water Grant (TDH, 1995). Although these data were gathered for a broader study, the data were reportedly collected in accordance with EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Fish Sampling and Analysis* (EPA, 1993) and analyses were performed in the TDH laboratory using EPA-approved methods for detection of metals, pesticides, PCBs, and semivolatile and volatile organic constituents. Aquatic species were collected to represent commonly consumed edible tissue taken by the public from sample locations in Sabine Lake (South), Sabine Lake (North), and Sabine Pass. A summary of the inorganic data from this investigation is presented in the table below. As shown, copper was detected in 3 of the 10 fish samples. The maximum detected concentration of copper in fish tissue (19 ppm) is much lower than the modeled fish tissue concentration (150 ppm) used in the risk calculations for the State Marine site.

METALS IN FISH TISSUE TAKEN FROM SABINE LAKE

METALS	LOCATION AND SAMPLE NO.									
	SABINE LAKE (SOUTH)				SABINE PASS	SABINE LAKE (NORTH)				
	4	5	6	7	8	9	10	11	12	13
	CONCENTRATION (PPM)									
ARSENIC	0.11	0.088	0.017	0.048	0.041	0.023	0.038	<0.014	0.031	0.038
CADMIUM	0.41	0.497	0.43	0.338	<0.037	0.513	<0.034	0.177	<0.039	0.162
COPPER	19.6	8.6	<0.4	8.8	<0.4	<0.4	<0.4	<0.5	<0.4	<0.4
LEAD	<0.074	0.163	0.055	<0.075	<0.037	0.047	<0.034	0.063	<0.039	0.049
MERCURY	<0.062	<0.049	<0.074	<0.072	0.161	<0.07	0.074	0.188	0.186	0.156
ZINC	344	35.3	2.9	31.6	3.1	3.1	3.5	3.9	2.9	3.6

EXHIBIT – 2
Metals in fish tissue taken from Sabine Lake
State Marine Superfund Site

Zinc in Sediment

Zinc is a risk driver for sediment in the HHRA. However, there is much uncertainty in the risk calculations due to the following reasons.

No significant source of zinc has been identified onsite. As expected (since zinc is a naturally-occurring element), zinc was detected in all 66 sediment samples. Zinc was analyzed in the background sediment dataset and was concluded to exceed background. The fish ingestion risk calculations are based on a 95% UCL concentration based on the 66 samples. Only two sediment locations exceeded risk-based concentrations for zinc.

The calculated HI is 5 using both RME and CT exposure scenarios. This level is slightly higher than the acceptable HI of 1.

The TDH prepared a risk assessment of Sabine Lake under EPA's Near Coastal Water Grant (TDH, 1995). Although these data were gathered for a broader study, the data were reportedly collected in accordance with EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Fish Sampling and Analysis* (EPA, 1993) and analyses were performed in the TDH laboratory using EPA-approved methods for detection of metals, pesticides, PCBs, semivolatile and volatile organic constituents. Aquatic species were collected to represent commonly consumed edible tissue taken by the public from sample locations in Sabine Lake (South), Sabine Lake (North), and Sabine Pass. A summary of the inorganic data from this investigation is presented in the table above. As expected, zinc was detected in all 10 fish tissue samples. The maximum detected concentration of zinc in fish tissue (344 ppm) is much lower than the modeled fish tissue concentration (4,300 ppm) used in the conservative risk calculations for the State Marine site.

1.4.1.9 Summary

In summary, dieldrin and heptachlor epoxide were identified as COCs in soil in the Maintenance Shed Area and the Nonsource Areas, respectively. These chemicals were only detected in a few locations onsite and are not expected to be associated with site activities, but background concentrations were not available for comparison. In addition, copper, zinc, and Aroclor 1242 were identified as COCs in sediment based on protection of fish ingestion exposures. However, the modeled fish tissue concentrations used in this HHRA are much higher than the measured fish tissue concentrations from Lake Sabine as reported by the Texas Department of Health, and therefore are expected to be overly conservative.

1.4.2 Ecological Risk Assessment Summary

The following sections summarize the approach, assumptions, and conclusions of the baseline ecological risk assessment (BERA) for the State Marine Superfund Site, conducted by CH2M HILL in July 2005 (CH2M HILL, 2005b).

The BERA is not a complete BERA outlining the full 8-Step process for ecological risk assessment under CERCLA. Instead, the BERA concludes after step 3 (Baseline Problem Formulation [BPF]), which consists primarily of a refinement of risk calculations in Steps 1 and 2 presented in the RI report for the site commonly referred to as Step 3a. The approach and assumptions presented below are consistent with the EPA-approved Ecological Risk Assessment Work Plan for the site (CH2MHILL, 2005c)

1.4.2.1 Data Used in the BERA

Soil

All historical surface (0-0.5’) soil data that were available to CH2M HILL electronically as of June 17, 2005, were used in the BERA. The available data consisted of soil samples collected in 1995 and 2001 from various areas, including six “hot spot” areas that were identified during the Expanded Site Inspection (TNRCC, 1996) and 2001 RI (Weston, 2003) based on historical activities performed in six distinct areas. The following soil data groupings were used in the BERA:

- Current Aboveground Storage Tank Area
- Former Lauren Tank Farm Area
- Former Wastewater Impoundments
- Maintenance Shed Area
- Tar Burn Area
- Wastewater Treatment Facility
- Non-Source Area

Sediment

All historical sediment data collected from the 0 to 6-inch interval and available to CH2M HILL electronically as of June 17, 2005, were used in the BERA. The available data consisted of sediment samples collected in 1995, 1999, and 2001. The sediment data were used to evaluate direct toxicity to lower trophic level organisms and to model whole-body biota tissue concentrations for consumption by wildlife. Data from other sources including the Palmer Barge and Calcasieu Estuary ERAs were used as a frame of reference.

Site data were split into three distinct groupings as presented previously in the RI Report and described below:

- Intertidal Area
- Near shore area
- Offshore area

Ground Water

Risk resulting from ground water would most likely present its greatest exposure to sediment dwelling organisms and the pathway would be addressed adequately through the evaluation of sediment chemistry data. No ground water seeps were observed during the site reconnaissance visit on June 17, 2005. However, ground water data from two shallow wells was analyzed to determine if ground water is a source contributing to contamination identified in sediments in Sabine Lake adjacent to the Site.

1.4.2.2 Refinement of Chemicals of Potential Ecological Concern (COPECs)

The COPECs were identified for soil and sediment by a five-part screening process that evaluates 1) frequency of detection, 2) background concentrations, 3) risk-based screening levels, 4) bioaccumulative COPECs, and 5) gradient analysis (soils only). In addition, chemicals that are considered to be essential nutrients (calcium, magnesium, potassium, and sodium) will not be selected as COPECs.

1.4.2.3 Contaminant Fate and Transport

Table 21 of the BERA Memorandum highlights contaminant fate and transport mechanisms. Table 22 of the BERA highlights mechanisms of ecotoxicity for all COPECs identified.

1.4.2.4 Ecosystems and Receptors Potentially at Risk

Based upon previous site investigations and review of threatened and endangered species lists for the area, the following feeding guilds and surrogate receptors were identified for evaluation:

- **Terrestrial –**omnivorous birds (northern bobwhite quail) and mammals (white-footed mouse), and carnivorous mammals (coyote)
- **Aquatic –**benthic invertebrates, omnivorous birds (spotted sandpiper), and carnivorous birds (belted kingfisher)

Carnivorous birds may frequent the Site and be exposed to COPECs. However, due to large home range sizes relative to the size of the Site and other site use factors, exposure from the site was considered sufficiently low such that evaluation of risk was not warranted.

Herbivorous birds and mammals may occasionally be found at the Site. This feeding guild was not evaluated because the majority of plant species found on site are not known to provide significant nutritional value. Thus, the main exposure route being evaluated, the ingestion pathway, would not be substantial for this feeding guild at this Site. The most likely scenario at the site is that any species of small bird or mammal living at the site would need to be more omnivorous in its diet to meet its nutritional requirements. Hence, omnivorous birds and mammals are much more likely to be found at the site and would have the greatest exposure potential and potential risk from site-related COPECs.

1.4.2.5 Conceptual Site Model

The existing draft ecological conceptual site model (CSM) presented in the RI Report was revised, as appropriate. The CSM presents potential chemical sources, release mechanisms, receptors, and exposure routes. Food web models are presented for the terrestrial and aquatic marine food webs present at the (see Figures 2 and 3 of the BERA).

1.4.2.6 Assessment Endpoints and Risk Questions

Assessment endpoints were developed for each feeding guild identified with complete significant exposure pathways to site-related contaminants. Measurement endpoints were selected for each assessment endpoint. Risk hypotheses were developed for each endpoint and conclusions were drawn at the end of the risk assessment as to whether the null hypothesis was accepted or rejected.

1.4.2.7 Complete Exposure Pathways

Exposure pathways not explicitly addressed in this BERA include 1) inhalation and dermal exposure pathways for upper trophic level organisms, 2) foliar uptake of dissolved COPCs by aquatic plants, and 3) risk to amphibians and reptiles, because these pathways currently lack enough accompanying toxicological exposure information and guidance for a complete quantitative evaluation (USEPA, 1999a).

Exposure to subsurface soil was not considered. Some burrowing mammals may be exposed to surface soils. However, it was assumed that the greatest exposure of the site-specific COPECs would be in surface soils where uptake by invertebrates and the shallow rooted plants found at the site would be the greatest.

1.4.2.8 Exposure Assessment

The EPA's Wildlife Exposure Factors Handbook (EPA, 1993) was the primary source of exposure factors data. The exposure to upper trophic level organisms was assessed by quantifying the daily dose of ingested contaminated food items (that is, plant and animal) and ingested media. Exposure to receptors was estimated using chemical-specific EPCs, bioaccumulation data, and several other factors such as species-specific body weights, ingestion rates, home range data, and area use factors. Prey tissue concentrations were estimated using chemical-specific bioaccumulation factors and bioaccumulation regression models. Site-specific tissue data were not available. Instead, tissue concentrations were modeled using literature data.

Benthic invertebrates were evaluated for direct toxicity to COPECs in sediment. EPCs were compared directly to media screening levels.

Fish tissue concentrations used in modeling ingestion by piscivorous birds were modeled using biota sediment accumulation factors. It was assumed that the fish from which these BSAFs were developed were from the same trophic level as those expected in the diets of piscivorous birds feeding adjacent to the Site.

Initial EPCs were established as maximum detected concentrations. 95% UCLs were only calculated for those COPECs for which risk estimates using maximum concentrations indicated risk. For those COPECs suggesting risk based on maximum detected concentrations, 95% UCLs were calculated using the most recent version of ProUCL. The final list of COPECs and EPCs used for the risk evaluation is presented in BERA Tables 27 and 28 for soil and sediment, respectively. For a handful of COPECs, EPCs were further refined to mean concentrations when 95% UCLs indicated risk. Mean concentrations were considered a reasonable exposure point concentration because, assuming available food sources and cover are equal throughout the exposure area, receptors would not spend a greater percent of their foraging time at any one point versus another (i.e., the higher concentration areas).

Area use factors (AUFs) were applied to exposure estimates based on the ratio of exposure area to home range. For herbivorous mammals, each source area onsite was evaluated as a separate exposure area. All site data were combined as one exposure area for the coyote and northern bobwhite. All sediment data were combined as one exposure area for the belted kingfisher. Risk estimates for the spotted sandpiper were calculated separately for the intertidal and nearshore exposure areas because it was anticipated that the intertidal area contained significantly higher concentrations and separate calculations would help focus the location of the risks. Since the combined area was slightly less than the home range, the risk estimates were combined to determine total risk and were proportioned as 20 percent from the intertidal area and 80 percent from the nearshore area, based on acreage. A site use factor (SUF) was also applied to the risk estimates for the spotted sandpiper. The majority of the species within the omnivorous bird feeding guild are not year round residents of the area and spend less than half the year at the site. A SUF of 50 percent was multiplied by the AUF to determine a combined site use factor for the spotted sandpiper risk estimates.

1.4.2.9 Effects Assessment

Toxicity values used in the screening level evaluation (Steps 1 and 2) were reevaluated and refined. The USEPA (1999a) toxicity reference value (TRV) selection hierarchy was used as guidance for identifying toxicity values used to develop TRVs and uncertainty factors were applied as directed when necessary. The EcoSSLs (USEPA, 2005), Toxicological Benchmarks for Wildlife: 1996 Revision (Sample et al. 1996), EPA's ECOTOX database, and EPA's draft *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (1999b) were consulted as possible sources for avian and mammalian TRVs.

For those constituents (if any) with missing toxicity values, toxicity values for proxy chemicals were used if available. Constituents with no appropriate proxy toxicity values were evaluated qualitatively.

1.4.2.10 Risk Characterization

Hazard quotients (HQs) were calculated by dividing EPCs by ecological risk-based screening levels for benthic invertebrates and exposure doses by toxicological reference values for wildlife. HIs were calculated for total low molecular weight PAHs (LPAHs) and high molecular weight PAHs (HPAHs) as the sum of HQs for individual PAHs.

All table numbers in the following subsections refer to the BERA (CH2M HILL 2005b) tables.

Terrestrial Omnivorous/Insectivorous Mammals:

No Observed Adverse Effect Level (NOAEL)-based HQs for the white-footed mouse in the former Wastewater Impoundments are presented in Table 31. The NOAEL-based HQ exceeds unity only for zinc (1.5). No Lowest Observable Adverse Effects Level (LOAEL)-based HQs exceed unity. Therefore, the risk to the omnivorous / insectivorous mammal feeding guild lies in the risk management area between the NOAEL and LOAEL. The risk was considered marginal and was not recommended for further analysis or risk management.

NOAEL-based HQs for the white-footed mouse in the Wastewater Treatment Facility are presented in Table 32. The NOAEL-based HQ exceeds unity only for zinc (1.9). No LOAEL-based HQs exceed unity. Therefore, the risk to the omnivorous / insectivorous mammal feeding guild lies in the risk management area between the NOAEL and LOAEL. The risk was considered marginal and was not recommended for further analysis or risk management.

NOAEL-based HQs for the white-footed mouse in the current above ground storage tanks are presented in Table 33. The NOAEL-based HQ exceeds unity only for chromium (1.3), lead (2.1), and zinc (1.7). The HI for HPAHs also exceeds unity (1.5). No LOAEL-based HQs or HIs exceed unity. Therefore, all the risks to the omnivorous / insectivorous mammal feeding guild lie in the risk management area between the NOAEL and LOAEL. These risks were considered marginal and were not recommended for further analysis or risk management.

NOAEL-based HQs for the white-footed mouse in the Maintenance Shed Area are presented in Table 34. The NOAEL-based HQ exceeds unity only for beta endosulfan (1.7), endrin aldehyde (1.5), and zinc (2.4). No LOAEL-based HQs exceed unity. However, the risk for beta-endosulfan is not bound by a LOAEL due to a lack of available toxicological data. While there is no certainty with where the LAOEL TRV would lie relative to the NOAEL TRV, an assumption that the LOAEL is as little as two times the NOAEL would yield an LOAEL HQ below unity. Of all the TRVs presented in Tables 27 and 28, only two LOAEL TRVs are less than two times the NOAEL TRV, so this assumption is well supported. Therefore, all the risks to the omnivorous / insectivorous mammal feeding guild lie in the risk management area between the NOAEL and LOAEL. These risks were considered marginal and were not recommended for further analysis or risk management.

NOAEL-based HQs for the white-footed mouse in the Tar Burn Area are presented in Table 35. The NOAEL-based HQ exceeds unity only for zinc (1.7). No LOAEL-based HQs exceed unity. Therefore, the risk to the omnivorous / insectivorous mammal feeding guild lies in the risk management area between the NOAEL and LOAEL. The risk was considered marginal and was not recommended for further analysis or risk management.

NOAEL-based HQs for the white-footed mouse in the Lauren Tank Farm are presented in Table 36. The NOAEL-based HQ exceeds unity only for alpha chlordane (1.3), cadmium (1.1), endrin aldehyde (53), and zinc (1.7). The HI for HPAHs also exceeds unity (1.7). LOAEL-based HQs also exceed unity for endrin aldehyde (5.3). No other LOAEL-based HQ or HI exceeds unity. Risk to the omnivorous / insectivorous mammal feeding guild from endrin aldehyde is recommended for further analysis or risk management.

NOAEL-based HQs for the white-footed mouse in the Non-source Area are presented in Table 37. The NOAEL-based HQ exceeds unity only for cadmium (5), carbazole (1.2), chrysene (1.1), dieldrin (114), endrin aldehyde (378), fluoranthene (3.5), heptachlor epoxide

(43), p,p'-DDE (1.6), and pyrene (2.3). The HI for HPAHs also exceeds unity (10). LOAEL-based HQs also exceed unity for dieldrin (14), endrin aldehyde (38), and heptachlor epoxide (4.3). No other LOAEL-based HQ or HI exceeds unity. The risk from zinc appears to be attributable to a data outlier and is discussed further in the uncertainty analysis. Risks to the omnivorous / insectivorous mammal feeding guild from dieldrin, endrin aldehyde, and heptachlor epoxide are recommended for further analysis or risk management.

Terrestrial Omnivorous/Insectivorous Birds:

HQs for the northern bobwhite quail are presented in Table 38. NOAEL-based HQs exceed 1.0 only for chromium, copper, lead, zinc, dieldrin, heptachlor epoxide, and DDT and its metabolites DDD and DDE. All HQs were below 10. No LOAEL-based HQs exceed unity. Therefore, the risk to the omnivorous / insectivorous bird feeding guild lies in the risk management area between the NOAEL and LOAEL. These risks were considered marginal and were not recommended for further analysis or risk management.

Terrestrial Carnivorous Mammals:

HQs for the coyote are presented in Table 39. No NOAEL-based or LOAEL-based HQs exceed 1.0. Therefore, there is no risk to the carnivorous mammal feeding guild. No further analysis or risk management is required.

Benthic Invertebrates:

Sediment concentrations from all three exposure areas in Sabine Lake were compared to primary and secondary effects levels indicative of toxicity to benthic invertebrate communities. Sediment concentrations from all three exposure areas in Sabine Lake were compared to primary and secondary effects levels indicative of toxicity to benthic invertebrate communities. The effects levels selected are those proposed by the TCEQ's Ecological Risk Assessment Workgroup in March 2004. For inorganic constituents, PAHs, DDTs, and PCBs the values are effects range low (ERLs) and effects range median (ERMs) values published by Long et al., 1995. For many of the VOCs, values were derived using equilibrium partitioning methodology as described in TNRCC 2001. Since few marine sediment screening values are available, these sources were given precedence and when not available, other sources such as AET values were considered for screening purposes.

Benthic invertebrates range from immobile to having fairly small home ranges; therefore, each exposure area was evaluated independently. Constituents were identified as COCs for benthic invertebrates when the maximum magnitude of exceedance of the primary effect level is greater than 10 or if the frequency of exceedance of the secondary effect level exceeds 20 %.

The analysis of the Intertidal Area indicates marginal or lower risk exists for all COPECs except lead (Table 40). The maximum magnitude of exceedance of the primary effect levels is less than 10 for all COPECs. For lead, the concentrations of two samples exceed the secondary effect level. For all other COPECs, one or fewer samples exceed the secondary effect level. Risks to benthic invertebrates for all COPECs except lead are marginal, do not require further analysis, and are not recommended for risk management. The risk to benthic invertebrates for lead requires further analysis and/or risk management.

The analysis of the nearshore area indicates marginal or lower risk exists for all COPECs (Table 41). The maximum magnitude of exceedance of the primary effect levels is less than 10 for all COPECs. For all COPECs, one or less samples exceed the secondary effect level with a maximum frequency of exceedance of less than 5 percent. Risks for all COPECs are marginal, do not require further analysis, and are not recommended for risk management.

For barium in the nearshore area, the concentrations of 20 samples exceed the primary effect level and no secondary effect level is available. Though approximately 45 percent of the barium samples exceed the primary screening value, the risk is not considered significant. The maximum magnitude of exceedance is less than ten. The value exceeded is the lowest of the available toxicity test results that was available for development of the Apparent Effects Thresholds. Perhaps more importantly, screening values are not readily available for barium in sediments. Of all the studies conducted over the years to develop screening values, no other studies have included barium. Barium is not generally considered toxic. Barium in the nearshore sediments is not recommended for further analysis or risk management.

The analysis of the Offshore Area indicates marginal or lower risk exists for all COPECs (Table 42). The maximum magnitude of exceedance of the primary effect levels is less than 10 for all COPECs and no sample concentrations exceed secondary effect levels. Risks to benthic invertebrates for all COPECs are marginal, do not require further analysis, and are not recommended for risk management.

Omnivorous/Insectivorous Birds:

HQs for the spotted sandpiper in the Intertidal Area are presented in Table 43. No NOAEL-based or LOAEL-based HQs exceed 1.0. HQs for the spotted sandpiper in the Nearshore Area are presented in Table 44. The NOAEL-based HQs for fluorene (3.2), manganese (2.6), phenanthrene (1.8), and thallium (2.1), exceed unity, as does the LPAH HI (5). No LOAEL-based HQs exceed unity. Table 45 presents the combined total HQs for the spotted sandpiper representing omnivorous/ insectivorous shore birds foraging in both the intertidal and nearshore areas. NOAEL-based HQs fluorene (3.3), manganese (3.4), phenanthrene (1.8), and thallium (2.1), exceed unity, as does the LPAH HI (5). No LOAEL-based HQs exceed unity. Risks to omnivorous/ insectivorous shore birds are marginal, do not require further analysis, and are not recommended for risk management. No further analysis or risk management is required.

Piscivorous Birds:

HQs for the belted kingfisher from the combined Intertidal, Nearshore, and Offshore Areas are presented in Table 46. Only the NOAEL-based HQ for zinc exceeds unity (7.5). No LOAEL-based HQs exceed unity. Therefore, the risk to the piscivorous bird feeding guild lies in the risk management area between the NOAEL and LOAEL. This risk was considered marginal and was not recommended for further analysis or risk management.

1.4.2.11 Uncertainty Assessment

Uncertainties are inherent in all risk assessments. The nature and magnitude of the uncertainties depend on the amount and quality of data available, the degree of knowledge concerning site conditions and the assumptions made to perform the assessment. A qualitative evaluation of the major general uncertainties associated with this screening assessment, in no particular order of importance, is outlined below:

- No avian and mammalian life history data specific to the site were available; therefore, exposure parameters were either modeled based on allometric relationships (e.g., food ingestion rates) or based on data from these same species in other portions of their range. Because diet composition as well as food, water, and soil ingestion rates can differ among individuals and locations, published parameter values may not accurately reflect individuals present at the site. As a consequence, risk may be either overestimated or underestimated.

- No site-specific data on concentrations in prey items were available. Therefore, concentrations in these prey items were estimated using literature-derived bioaccumulation models. The suitability of these models is unknown. As a consequence, concentrations of COPECs in actual prey may be either higher or lower than the data used in this screen.
- Literature-derived toxicity data based on laboratory studies were the only available toxicity data used to evaluate risk to all receptor groups. It was assumed that effects observed in laboratory species were indicative of effects that would occur in wild species. The suitability of this assumption is unknown. Consequently, the risk may be either overestimated or underestimated.
- Dietary compositions were simplified for the site receptors to estimate concentrations in food items using bioaccumulation models. It was assumed that concentrations were similar in comparable food types. The suitability of this assumption is unknown. Consequently, risk may be either overestimated or underestimated.
- Because toxicity data specific for bird and mammal species at the site were not available, it was necessary to extrapolate toxicity values from test species to site receptor species. Although scaling factors were employed (Sample and Arenal, 1999), these factors are not chemical-specific and are based on acute toxicity data. As a consequence, risk may be either overestimated or underestimated.
- In this screen, risks for most chemicals were each considered independently. Because chemicals may interact in an additive, antagonistic, or synergistic manner, the evaluation of single-chemical risk may either underestimate or overestimate risk associated with chemical mixtures. The risk from PAHs and organochlorine pesticides were summed to determine the combined risk.

- Detection limits for some data were insufficient because they were greater than ecological screening values. These compounds were carried forward in the risk assessment and evaluate for effects on wildlife using one-half the detection limit as a proxy value for non-detects. This assumption could either under- or overestimate risk depending on the true concentration of those constituents.

- All sediment data used in the risk assessment is a minimum of four years old. The Site is located along Sabine Lake adjacent to a canal that receives regular boat traffic and is dredged every two to three years. The sediments in this area are also subject to tidal movements. Sediments located in such an active area are not likely to remain constant, and as such, the available data from 2001, 1999, and 1995 are neither necessarily reflective solely of site-related influence, nor are they definitively representative of existing conditions.

- There is a lack of spatial coverage for pesticide data at the Site. Pesticides were detected in some of the source areas; however, there was insufficient sample coverage to determine if site related gradients exist. Samples were not collected in many areas surrounding pesticide detections. In these areas, risk could be either under- or overestimated, depending on the concentration in the surrounding area relative to the EPC that was used in the risk estimates.

- Risk was not calculated for reptiles and amphibians due to insufficient toxicological data and site-specific data. Some species of omnivorous birds have similar diets to those of omnivorous reptiles and amphibians. Hence, conclusions for the omnivorous bird feeding guild were considered representative of the reptiles and amphibians likely living on the Site.

- Risk was not calculated for terrestrial plants or invertebrates. No endangered plant or invertebrate species were identified within the area. Significant plant and insect species were noted as thriving within the Site during the last site visit on June 17, 2005. Thus, these lower trophic level organisms were not considered assessment endpoints for the Site.

- Toxicity information adequate to quantify ecological risks was not available for some detected constituents. In some cases, data for surrogate chemicals were used. The use of surrogate toxicity information to quantify toxicity for these contaminants might lead to overestimates or underestimates of risk to ecological receptors. For some constituents, there is no information available from which to develop TRVs. Consequently; these constituents could not be evaluated. There is no information available from which to develop TRVs for 13 COPECs for birds and 1 COPEC for mammals. For some COCs, there is a mammal TRV but no avian TRV or vice versa. The uncertainty of risk to one class of receptors in these cases is reduced by the lack of quantifiable risk to the other class of organisms. Use of surrogates for exposure and effects assessments

- The exposure dose estimates in this screening risk assessment assume that 100 percent of the chemical concentrations to which receptors are exposed are in the bioavailable form. Most chemicals will not be 100 percent bioavailable. In the cases where bioavailability is less than 100 percent, risk is overestimated.

(This page intentionally left blank.)

2. Development of RAOs and PRGs

This section provides a discussion of development of RAOs and PRGs, as well as an evaluation of ARARs related to the State Marine Site.

2.1 Applicable or Relevant and Appropriate Requirements

Remedial actions must protect public health and the environment. Section 121(d)(2) of the CERCLA requires that federal and state ARARs be identified, and that response actions achieve compliance with the identified ARARs. This requirement makes CERCLA response actions consistent with pertinent federal and state environmental requirements as well as adequately protecting public health and the environment.

Under CERCLA, a requirement may be either "applicable" or "relevant and appropriate" to a specific response action. The National Contingency Plan (40 CFR §300.5) defines "applicable" and "relevant and appropriate" requirements as follows:

- **Applicable requirements** are defined as those cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- **Relevant and appropriate requirements** are defined as those cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site so their use is well suited to the particular site.

"Applicability" implies that the remedial action or the site circumstances satisfy all the jurisdictional prerequisites of a requirement. The "relevance and appropriateness" of a requirement is evaluated based on site-specific factors and professional judgment. A requirement must be either applicable or both relevant and appropriate to be an ARAR.

ARARs are divided into three categories: contaminant-specific, action-specific, and location-specific. Definitions of these classifications are described in the following subsections.

- **Contaminant-Specific ARARs** are promulgated values that include health or risk based standards, numerical values, or methodologies that, when applied to site-specific conditions, establish the acceptable amount or contaminant concentration that may be detected in or discharged to the ambient environment. These values focus on protecting public health and the environment. However, technological or cost limitations may influence some values, such as maximum contaminant levels (MCLs).

- **Location specific ARARs** relate to the geographical position of the site, such as state and federal laws and regulations that protect wetlands or construction in floodplains. The extent to which any location-specific requirements may be considered depends solely on the sensitivity of the environment and any possible impact caused by remedial activities.

- **Action-specific ARARs** are technology- or activity-based requirements or limitations on actions taken regarding hazardous substances, pollutants, and contaminants. This report selected action-specific ARARs for this site based on potential remedial action alternatives.

A list and description of ARARs identified for the site were compiled based on the framework described above, and divided into three categories:

- Contaminant or Chemical-Specific ARARs (**Table 2.1**)

- Location-Specific ARARs (**Table 2.2**)

- Action-Specific ARARs (**Table 2.3**)

In addition to the three categories, some EPA and state guidelines are categorized as "to be considered" (TBC). The TBC criteria are non-promulgated, non-enforceable guidelines or criteria useful for developing a remedial action or necessary for evaluating what protects human health and/or the environment. Examples include EPA references doses and risk specific doses. The guidelines to be considered are identified in **Table 2.4**.

Factors that influence the definition of ARARs for the site include the proximity of the Sabine-Neches Channel, the wetlands adjacent to the site, the elevated contaminant levels in both soil and ground water, and the activities that could be a part of the potential response actions as discussed in this report.

2.2 Development of Remedial Action Objectives

RAOs are developed to specify the COCs, exposure route(s) and receptor(s), and an acceptable contaminant level or range of levels for each exposure route, i.e., PRGs (EPA, 1988). As a function of establishing RAOs and PRGs, ARARs must be reviewed to identify the promulgated federal and state standards that will or may affect the selection of response actions for the site, and future land use of the site should be considered.

Based upon the presumed nature and extent of soil and sediment contamination, there appears to be potentially unacceptable risks to human health and the environment at the site. Development of the RAOs for the soil and sediment at State Marine site was based on:

- The types and concentrations of contaminants in the soil/sediment.
- The possible need to protect ground water quality.
- The potential ecological and human health risk associated with the contaminated soil/sediment.
- The need to reduce site safety hazards.

The RAOs are as follows:

- Prevent exposure to contaminated soil/sediment via ingestion, inhalation, or dermal contact that would result in an excess carcinogenic risk of 1×10^{-5} or an HI of 1.
- Prevent exposure of contaminated soil/sediment to aquatic or terrestrial organisms via direct contact or indirect ingestion of bioaccumulative chemicals that would result in an HQ of 1.

- Prevent or minimize migration of soil contaminants to ground water.
- Prevent or minimize further migration of soil and sediment contaminants to surface water that could result in exceedance of ambient water quality criteria.

2.3 Preliminary Remediation Goals

2.3.1 HHRA PRGs

Preliminary remediation goals, or cleanup goals, were developed for the exposure areas where the total risk for a receptor exceeded $1x10^{-5}$ or an HI of 1. The PRGs were developed for the COPCs with an individual ELCR exceeding $1x10^{-5}$ or HI of 1, based on these target risk levels. The same exposure factor values used in the exposure assessment were used to calculate PRGs. The PRGs are described below:

- **Maintenance Shed Area** – A PRG was identified for protection of ingestion, dermal contact, and inhalation exposures to dieldrin in soil by current and future industrial / commercial workers. The cleanup goal of 1.2 mg/kg is based on a $1x10^{-5}$ ELCR for this receptor. Detected concentrations in two samples collected from this area exceed the PRG.
- **Non-source Areas** – A PRG was identified for protection of ingestion, dermal contact, and inhalation exposures to heptachlor epoxide in soil by current and future industrial / commercial workers. The cleanup goal of 2.1 mg/kg is based on a $1x10^{-5}$ ELCR and HI less than 1 for this receptor. The detected concentration in one sample collected from this area exceeds the PRG.
- **Sediments in Lake Sabine** – A PRG was identified for protection of exposures to Aroclor 1242, copper, and zinc in edible fish tissue by current and future receptors eating fish caught in Lake Sabine. The cleanup goal of 1.5E-4 mg/kg for Aroclor 1242 is based on a $1x10^{-5}$ ELCR for this receptor. The detected concentration of Aroclor 1242 in one sample (SE-9) collected from sediment exceeds the PRG. The cleanup goals of 91 and 734 mg/kg for copper and zinc, respectively, are based on a HI of 1 for this receptor. The detected concentrations in four and two locations, respectively, exceed the PRGs for copper and zinc.

Figure 2-1 shows the distribution of samples that exceed human health (and ecological)PRGs for soils, and **Figure 2-2** shows the distribution of sediment samples that exceed human health PRGs for sediments.

2.3.2 BERA PRGs

Preliminary remediation goals were developed in the Baseline Ecological Risk Assessment (BERA). Any risks remaining after completion of the uncertainty analysis are considered COCs instead of COPECs. Based on calculated risks, PRGs were developed for COCs in soil and sediment. PRGs were calculated based upon the most sensitive receptor that presented risk to a given COC within a given exposure area. PRGs represent the midway point between no-effect and lowest effect levels for wildlife or between primary and secondary effect levels for sediment dwelling organisms.

The ecological risk assessment evaluated risk in six source areas onsite and three areas within Sabine Lake using data available from previous studies conducted in 1995, 1999, and 2001. Surface soils were evaluated for risk to wildlife from the site source areas and non-source areas individually and combined. Risk was identified for three organochlorine pesticides in the former Lauren Tank Farm Area and the Non-source Area. PRGs were developed for dieldrin, endrin aldehyde, and heptachlor epoxide for exposure to omnivorous mammals feeding within these exposure areas. **Figure 2-1** shows the distribution of soils exceeding ecological PRGs at three soil hot spot areas.

Risk was also identified for the benthic invertebrate community that may be living in the intertidal area along the banks of the site. Lead concentrations within three sediment hot spot areas exceed PRGs for benthic organisms. **Figure 2-3** shows the distribution of sediment samples exceeding ecological PRGs for lead.

A study of the bioavailability of the metals in sediments at the site also indicates that the metals are available and likely to be toxic in these areas. Data gaps surround the ecological risks identified in both soil and sediment. For soil risks, a limited amount of pesticide data is available. Spatial coverage was inadequate to develop average risk levels, so results are based upon maximum exposure, which could either overestimate or underestimate true risks. Risks identified in sediments do not take into account site specific information including toxicity studies, community analysis if the existing benthic community in the intertidal area, or evaluation of the available habitat onsite. Site specific information could suggest that the identified risks are overestimated or do not exist. An additional consideration is that due to the transient nature of sediments and the highly active surroundings, data that is four years old or older may not be reflective of current conditions. The source of contamination in sediment was not identified with certainty but analysis of lead in ground water does exceed screening values developed to be protective of the ground water to sediment exposure pathway.

The exact source of lead contamination in sediments is uncertain. Ground water is a potential source. The concentration of lead in ground water samples collected during the RI in 2001 (20 µg/L) is two orders of magnitude greater than the screening value. This indicates that ground water from the site could be a potential source of lead to sediments in the intertidal area, which indicates toxicity to benthic organisms.

While PRGs are presented for each medium, within Step 8 of the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final* (EPA, 1997), the following two statements are made:

- "The risk manager must balance (1) residual risks posed by site contaminants before and after implementation of the selected remedy with (2) the potential impacts of the selected remedy on the environment independent of contaminant effects."
- "In instances where substantial ecological impact will result from the remedy (e.g., dredging a wetland), the risk manager will need to consider ways to mitigate the impact of the remedy and compare mitigated impacts to the threats posed by the site contamination."

Net Environmental Benefit Analysis (NEBA) provides a framework to meet this guidance. A NEBA can be conducted to support the selection of remedial alternatives for sediments adjacent to the Site. The purpose of the NEBA is to develop information for EPA work authorization manager (WAM) and other stakeholders to enable the development of a defensible, scientifically based, cleanup approach at the Site. The overall goal is to identify potential remedial alternatives that would provide for the protection of human health and the environment while providing the greatest net ecological value. Within the NEBA, preliminary assumptions can be made regarding various input parameters and as such, this analysis is exploratory in nature and can be revised as necessary. NEBA is recommended as a method to assist in remedial decision making at this site. A NEBA will be presented as a part of the FS for the site. The key stakeholders would be expected to work collaboratively to further refine the analyses in order to suit those purposes, based on the best information available at that time. **Section 3.2** of this FFS summarizes the NEBA evaluation.

2.4 Contaminated Media Area and Volume Exceeding PRGs

Due to the lack of analytical data for samples with COCs exceeding PRGs, a conservative approach was developed to determine the contaminated area associated with each sample. For each of the exceedances, a 50-foot radius circle was circumscribed around the sample point. The enclosed area represents the estimated contaminated media corresponding to each sample point exceeding PRGs. This area was used as the basis for developing volumes, assuming a 2-foot depth of material for soil and 1-foot depth for sediment. Ecological and human health hot spots were used to develop soil volume estimates. Ecological hot spots were used to develop sediment volume estimates.

- Soil areas and volumes exceeding ecological and human health PRGs are shown on **Figures 2-4** through **2-6**.
- Sediment areas and volumes exceeding ecological PRGs are shown on **Figures 2-7** and **2-8**.

3. Development and Screening of Alternatives

The purpose of this section is to provide a summary of development and screening of remedial alternatives for the State Marine Site.

3.1 Identification and Screening of Remedial Alternatives

Preliminary general response actions (GRAs) were selected and evaluated as part of a technical memorandum prepared by CH2M HILL in 1999 for the State Marine Site (CH2M HILL 1999). These general response actions satisfy the RAOs and PRGs by either reducing concentrations of hazardous substances or by reducing the likelihood of contact with hazardous substances. They include actions such as treatment, containment, collection, disposal, and institutional controls. Although one response action may meet the goals, a combination of response actions may meet the goals more effectively. The general response actions previously considered for the State Marine Site include:

- No action
- Monitoring
- Institutional controls
- Net Environmental Benefit Analysis
- Containment
- In situ treatment
- Ex situ treatment
- Excavate/disposal

Initial identification and screening of remedial technologies along with development of remedial alternatives were performed as part of the 1999 technical memorandum (CH2M HILL 1999). The technology types and process options available for remediation of both soil and sediment media were screened for suitability. The purpose of this step is to screen the technologies that are clearly not applicable for remediation at the site and to retain the best technology types and process options within each GRA and use them for developing remedial alternatives.

Each technology type and process option that is retained is either a demonstrated, proven process or a potential process that has undergone laboratory trials or bench-scale testing. The factors included in this evaluation include the state of technology development, site conditions, waste characteristics, the nature and extent of contamination, and the presence of constituents that could limit the effectiveness of the technology. Entire technologies and individual process options are screened from further consideration based on technical implementability.

Technologies and process options retained after the initial screening are further evaluated using a qualitative comparison based on effectiveness, implementability, and cost. Following this qualitative screening, those remedial technology types and process options that are considered viable for remediating the soil and sediment at the site are carried forward for development into alternatives.

The 1999 technical memorandum looked at a range of remedial options for the soil and sediment at the site that exceeded PRGs and screened those technologies to develop preliminary remedial alternatives.

Based on the results of the screening process in the 1999 technical memorandum, a preliminary list of remedial alternatives was developed, as summarized below.

Alternatives considered for soil included:

- No Further Action
- Institutional Controls
- Net Environmental Benefit Analysis (NEBA)
- In Situ Treatment
- Containment

- Excavation/Offsite Disposal

Alternatives considered for sediment included:

- No Further Action
- Institutional Controls
- Net Environmental Benefit Analysis
- Containment
- Excavation/Offsite Disposal

Subsequent to the submittal of the 1999 technical memorandum, an RI and screening level risk assessment was performed by Weston. The remedial investigation report was completed in April 2003 (Weston, 2003).

Based on the conclusions of the RI report and the human health and ecological risk assessments, summarized in **Section 1.4** of this document, the remedial alternatives identified in the 1999 Technical Memorandum were updated and modified to reflect the current understanding of the Site. A preliminary screening evaluation of these alternatives was developed during the FS process and is provided in **Table 3-1** and **Table 3-2** for soil and sediment, respectively. The NEBA alternative was not retained for this FFS since the NEBA will be used as a tool to evaluate and screen alternatives based on their overall impacts to the environment, rather than a stand-alone remedial alternative. The NEBA evaluation is provided in **Section 3.2**.

3.1.1 Remedial Alternative Screening Summary for Soil

Based on the evaluation of soil remedial alternatives provided in **Table 3-1**, the following alternatives have been retained for detailed and comparative analysis in the FFS.

- No Further Action
- Institutional Controls
- Onsite Soil Cover
- Excavation/Treatment/Offsite Disposal

3.1.2 Remedial Technology Screening Summary for Sediment

Based on the evaluation of sediment remedial alternatives provided in **Table 3-2**, the following alternatives have been retained for Net Environmental Benefit analysis in this FFS.

- No Further Action
- Monitored Natural Attenuation (MNA)
- Excavation/Treatment/Offsite Disposal

3.2 Net Environmental Benefit Analysis

This section provides a summary of the NEBA conducted for sediments at the Site. The NEBA is included as **Appendix A** of this FFS.

The purpose of the NEBA was to develop information that would enable the development of a defensible, scientifically-based cleanup approach for sediment. The overall goal was to identify potential remedial alternatives that would provide for the protection of the environment while providing the greatest net ecological value.

The NEBA process is consistent with the risk management objectives outlined in Superfund guidance. Within Step 8 of the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final* (EPA, 1997), the following two statements are made and NEBA provides a framework to meet this guidance:

- "The risk manager must balance (1) residual risks posed by site contaminants before and after implementation of the selected remedy with (2) the potential impacts of the selected remedy on the environment independent of contaminant effects."
- "In instances where substantial ecological impact will result from the remedy (e.g., dredging a wetland), the risk manager will need to consider ways to mitigate the impact of the remedy and compare mitigated impacts to the threats posed by the site contamination."

A NEBA is a process for comparing the benefits and costs associated with remedial action alternatives that affect the environment and was first used by EPA. The goal of a NEBA analysis is to rank these alternatives in terms of the total benefits realized from their implementation. A NEBA typically considers a broader range of environmental effects than the traditional RI/FS or RFI risk assessment process. These processes consider only the effects of the remedial alternatives in limiting exposure from a contaminant release so the risks to human health and the environment are not unacceptable. The effects to other natural resource services (e.g., human use value, ecological service value) provided by the Site are typically not considered in the standard RI/FS or RFI risk assessment process. A NEBA evaluates both the positive and negative effects on natural resource services associated with a remedial action, as well as the potential incremental change in risk associated with each alternative. By considering the effects on all natural resource services provided by the Site, the net effects of remedial alternatives on all natural resource service flows are considered, including any potential loss of services being provided. For some cases, the remedial action may destroy or significantly degrade the ecological landscape, while achieving little or no reduction in ecological or human health risk. In some cases, the remediation may not result in a better quality habitat.

A NEBA is a credible method to quantify, compare, and demonstrate that one remedy may be better for an ecosystem than another. NEBA and Habitat Equivalency Analysis (HEA), a natural resource economic model commonly used in a NEBA, have been successfully applied to support natural resource damage assessments (NRDAs), to evaluate remedial alternatives under CERCLA and Resource Conservation and Recovery Act (RCRA), and to make decisions regarding permitting under the Clean Water Act (CWA).

The key tenets of NEBA are:

1) affected habitats provide natural resource services and have value;
2) remediation may not necessarily increase the level of natural resource services; and
3) habitats can be destroyed as a result of remediation, causing natural resource injury.

The NEBA conducted for the Site considers natural resource values (i.e., ecological values), risk profiles, and costs to provide a framework from which EPA can reach a non-arbitrary, defensible basis for decisions regarding site cleanup.

The NEBA conducted for the Site compares potential remedial alternatives for consideration in the FS development. The available data indicate the potential for marginal ecological risks associated with the intertidal area. Given that the risks are marginal, the impact of each remedial alternative on ecological services was considered. Within the NEBA, assumptions were made regarding various input parameters and as such, this analysis is exploratory in nature. The key stakeholders would be expected to work collaboratively to further refine the analyses in order to suit those purposes based on the best information available at that time.

The results of the NEBA presented and in **Appendix A** suggest that MNA is the best remedial alternative for the intertidal area at this time. The NEBA considered not only the net impact to the environment, but also the amount of residual risk left in place and the cost of the remedial action.

Based on the results of the NEBA, it is evident that alternatives that include the removal of the existing contamination result in a similar to slightly greater net loss of ecological services compared with those left in place. However, the costs associated with the removal actions are significantly higher to remove risks that are uncertain. Thus, excavation of the sediments could be eliminated because in addition to having a greater net loss of ecological services, it also represents a more costly alternative compared to the No Action or MNA alternatives. MNA represents a better solution than No Action because there is currently insufficient data to determine if the natural attenuation will be successful and if active sources of contamination still exist.

Since MNA typically requires a contingency remedy in case performance monitoring shows that RAOs are not being achieved in a timely fashion, the Excavation/Treatment/Offsite Disposal alternative will be carried through detailed and comparative analysis in this FFS.

3.3 Alternatives Development for Soil

This section provided a detailed development of each of the soil remediation alternatives to address the three soil hot spot areas where COCs exceed human health and ecological PRGs at the State Marine Site.

3.3.1 Alternative A-1: No Further Action

The objective of the No Further Action alternative is to provide a baseline for evaluation of remedial alternatives as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control the continued release of COCs.

3.3.2 Alternative A-2: Institutional Controls

The objectives of institutional controls are to prevent direct exposure to the contaminated soils. Institutional controls would consist of access and deed restriction for the areas exceeding PRGs. A fence would be placed to restrict access. A statement would be added on the deed of the property identifying the area and specifying the following:

- Excavation within the area must comply with Occupational Safety and Health Act (OSHA) requirements for health and safety protection
- Any excavated soils should be managed as either solid or hazardous waste in accordance with applicable laws
- Buildings are not permitted within the contaminated soil area
- Shallow ground water, if it is available, may not be used
- Future land use will be limited to commercial or industrial uses

3.3.3 Alternative A-3: Onsite Soil Cover

This alternative consists of a clean soil cover used in conjunction with grading and vegetative cover over the three soil hot spot areas. A total area of approximately 53,600 ft^2 will be covered assuming a minimum overlap of 10 feet beyond the limits of the contaminated soil hot spot areas. The areas to be covered are shown on **Figure 3-1**. A typical cover cross-section is shown in **Figure 3-2**. The soil cover consists of the following components:

- Separation geotextile
- 24-inch layer of compacted clay
- 6-inch layer of topsoil
- Vegetative cover

Existing vegetation would be mowed or stripped (as needed) from the construction site and the area would be graded to provide an adequate subgrade for construction of the soil cover. A separation geotextile would be placed over the prepared subgrade to provide a visual delineation between contaminated soils and the clean soil cover. The clay cover would be placed and compacted in 6-inch lifts to a minimum thickness of 24-inches. A 6-inch topsoil layer would be placed to support the vegetative cover.

The cover would be graded to provide a minimum 2 percent slope with 4 horizontal:1 vertical sideslopes at the edges of the cover to match existing grade. The cover system would be designed to reduce infiltration to ground water to minimize the potential for further migration of COCs to shallow ground water. The hydraulic conductivity of the soil cover would range from 1 x 10^{-5} cm/sec to 1 x 10^{-7} cm/sec.

Detailed procedures for construction quality control and assurance (CQC/CQA) will be required during installation of the soil cover. Following construction, the condition of the soil cover system will be visually monitored annually as part of the O&M plan. Settlement resulting in ponding, erosion, or other defects in the cover integrity will be noted and repaired. Routine maintenance will include mowing and re-seeding, if necessary.

upgradient

3.3.4 Alternative A-4: Excavation/Treatment/Offsite Disposal

The excavation, treatment, and offsite disposal alternative consists of excavating contaminated soils that exceed PRGs within the three soil hot spot areas. The major remedial components of this alternative include the following:

- Excavation of soils containing COCs that exceed PRGs.
- Backfill of the areas excavated with clean, low permeability soil to meet landfill cover requirements
- Ex situ treatment (onsite or offsite, as appropriate) to meet land disposal restrictions
- Offsite disposal of removed/treated material

Each of these components is discussed in the following sections.

3.3.4.1 Excavation

This alternative will meet the cleanup objectives by removing the soil with contaminant concentrations exceeding PRGs. The area to be excavated is defined by the limits of excavation shown on **Figure 3-3**. A typical excavation section is shown in **Figure 3-4**. This alternative will include removal of soil overlying the landfill waste, which is estimated at an average thickness of 2 feet (based on descriptions of the original landfill cover). It is assumed that excavation will not proceed into the landfill waste. The approximate (in place) volume of soil to be disposed offsite is assumed to be 2,750 cubic yards.

Confirmatory sampling will be conducted to minimize the excavation area; however, confirmatory samples will not be collected within the underlying landfill waste.

Excavated soils exceeding the PRGs will be sampled and analyzed for toxicity characteristic leaching procedure (TCLP) parameters. Soils not failing TCLP will be loaded on trucks for offsite disposal. Soils exceeding TCLP limits will be treated offsite, as described below.

3.3.4.2 Soil Backfill and Cover

After completion of excavation, a soil backfill and cover system will be constructed to meet landfill cover requirements. A typical soil cover section is shown in **Figure 3-5**. Since contaminated soils are removed, minimal overlap of the cover area would be required beyond the limits of the soil hot spot excavation areas. A total area of approximately 39,200 ft^2 will be covered.

This soil cover system consists of the following layers:

- 24-inch layer of compacted clay
- 6-inch layer of topsoil
- Vegetative cover

Upon completion of soil hot spot excavation, the subgrade would be prepared for installation of the soil cover. The clay backfill would be placed and compacted in 6-inch lifts to a minimum thickness of 24-inches. A 6-inch topsoil layer would be placed to support a vegetative cover.

The cover would be graded to provide a minimum 2 percent slope with 4 horizontal: 1 vertical sideslopes at the edges of the cover to match existing grade. The cover system will be designed to reduce infiltration to ground water in order to minimize the potential for further migration of COCs, since underlying landfill wastes may have been further contaminated by State Marine operations. The hydraulic conductivity of the soil cover would range from 1 x 10^{-5} cm/sec to 1 x 10^{-7} cm/sec.

3.3.4.3 Offsite Disposal

Soils excavated under this alternative will be hauled offsite for disposal, and will be classified under Texas guidelines for classification of industrial and hazardous waste. Composite soil samples will be collected at a minimum of 1 sample for 500 cubic yards of material. The results will be analyzed and compared against TCLP limits. Once the soils are treated and/or pass the TCLP test, they will no longer be a hazardous waste and can be disposed in a licensed landfill. Soils that do not meet land disposal restrictions will require treatment.

The TCEQ offers waste classification guidance in their publication, *Guidelines for the Classification & Coding of Industrial Wastes and Hazardous Wastes* (TCEQ, February 2005). Title 30, Sections 335.501 and 335.521 of the Texas Administrative Code (TAC) include criteria for classifying nonhazardous, industrial wastes. The state has three classifications: Class I, II, and III. The soil should be classified in accordance with the TCEQ procedures.

3.3.4.4 Ex Situ Treatment

Soils exceeding TCLP limits must be treated before disposal in a landfill. Two technologies are selected for the ex situ treatment: chemical oxidation and solidification/stabilization. Chemical oxidation will be used to remove organic contaminants from soil. For heavy metal contaminated soils, however, solidification/stabilization technology would be more effective. The two ex situ treatment technologies would be necessary for this site because both organic and inorganic contaminants are present in the soils at elevated concentration levels. Ex situ treatment would be performed at the waste disposal facility.

Solidification/stabilization of soil that fails TCLP testing for metals will be performed at the disposal facility by mixing the soil with cement. Chemical oxidation of soil that fails TCLP testing for pesticides or PCBs will also be performed at the disposal facility. Confirmatory sampling and analysis will be performed to assess the effectiveness of the treatment(s).

3.4 Alternatives Development for Sediment

This section provides a detailed development of each of the sediment remediation alternatives to address sediment hot spot areas where COCs exceed human health PRGs at the State Marine site.

3.4.1 Alternative B-1: No Further Action

The objective of the no further action alternative is to provide a baseline for evaluation of remedial alternatives as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control the continued release of COCs.

3.4.2 Alternative B-2: Monitored Natural Attenuation

The objectives of this alternative are to prevent direct exposure to the contaminated sediments while the natural attenuation process occurs. The individual components of MNA are discussed in the sections below.

Natural attenuation relies on natural physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil, sediment or ground water (EPA, 1999a). These in situ processes include biodegradation; dispersion; dilution; sorption; volatilization; chemical or biological stabilization, transformation, or destruction of contaminants. For sediment, continuing deposition of clean sediment on top of contaminated sediments would limit direct contact to contaminated sediments. This mechanism is particularly relevant to the State Marine site due to the proximity of the Sabine-Neches Canal, which is routinely dredged.

The major components of this alternative are:

- Review of existing characterization data and collection of additional site characterization data to adequately define the nature and extent of sediment contamination to establish a baseline from which to evaluate the degree to which natural attenuation is occurring
- Performance monitoring to assess the effectiveness of natural attenuation processes over time

Existing site characterization would need to be supplemented to further delineate the sediment hot spots. Additional sampling would be conducted to determine the areal extent of the hot spot as well as performing site specific bioassays. Once the current nature and extent of COCs is adequately defined, performance monitoring would be conducted to assess the rate at which natural attenuation processes are achieving remedial action objectives. The performance monitoring would include annual sampling events for the first five years, and could include follow up events less frequently until PRGs are achieved.

3.4.3 Alternative B-3: Excavation/Treatment/Offsite Disposal

The excavation, treatment, and offsite disposal alternative consists of excavating sediments with contaminant concentrations that exceed PRGs within the sediment hot spot areas. The major remedial components of this alternative include the following:

- Excavation of sediments containing COCs that exceed PRGs
- Sediment dewatering
- Ex situ treatment to meet land disposal restrictions
- Offsite disposal

Each of these components is discussed in the following sections.

3.4.3.1 Excavation

This alternative will meet the cleanup objectives by removing the sediment with contaminant concentrations exceeding PRGs. The area to be excavated is defined by the limits of excavation. This alternative will include removal of sediment to an assumed depth of 1 foot. The approximate volume of sediment to be disposed offsite is assumed 800 cubic yards. Confirmatory sampling will be conducted to minimize the excavation volume.

Excavation of sediment would be accomplished by barge or pontoon mounted mechanical excavation equipment (track-hoe or back-hoe). Materials excavated would be placed in a material handling barge, which would be taken to an off-loading location. Due to the previous use of the site as a barge cleaning facility, it is likely that off-loading of the sediment could be accomplished at the site, and would not require transport to an offsite facility for off-loading.

Excavation of sediments would require installation of a containment area to isolate remedial actions from the surrounding surface water for turbidity/re-suspension management. The containment area would consist of installing a floating turbidity screen around the work area, and may require double containment through use of a turbidity screen curtain if site-specific conditions require an added measure of protection.

Water quality monitoring would be conducted to ensure that no release of COCs occurs to Sabine Lake. An extensive permitting effort is expected to implement sediment removal.

3.4.3.2 Sediment Dewatering

After sediments have been off-loaded, the sediment will be dewatered to reduce the moisture content prior to transport and disposal. Sediment de-watering could be accomplished through two methods.

The first method includes construction of a sediment dewatering impoundment onsite where sediment would be placed and allowed to settle. Construction of a sediment dewatering impoundment would require clearing an area and constructing perimeter berms. Upon completion of sediment dewatering activities, some of the underlying soils would need to be removed and disposed along with the sediments.

Upon initial settlement of the sediment, decant water would be collected and treated in an onsite treatment system prior to discharge. A National Pollutant Discharge Elimination System (NPDES) or Texas Pollutant Discharge Elimination System (TPDES) permit would be required in order to discharge treated waters to Sabine Lake.

After initial solids settle and decant water is pumped off, evaporation would continue to reduce the moisture content of the sediment. The sediment would be mixed with standard excavation equipment in order to promote uniform drying and to speed the process. This operation would continue until the moisture content is acceptable for landfill disposal.

A second method that can be employed to reduce the moisture content of the sediments is through the use of an absorbent. The absorbent would be added to absorb excess water within the sediment prior to shipping to the disposal facility. Addition of adsorbent has the disadvantage of increasing volume and weight of the sediments, which in turn, increase disposal costs.

3.4.3.3 Offsite Disposal

The process for offsite disposal of excavated sediments would be the same as for soil Alternative A-4, as described in **Section 3.3.4.3**.

3.4.3.4 Ex Situ Treatment

The ex situ treatment options for sediment are the same as for soil Alternative A-4, as described in **Section 3.3.3.4**.

4. Analysis of Remedial Alternatives

4.1 Evaluation Criteria

In accordance with the NCP, evaluation criteria were used to evaluate technical and policy considerations that are important for selecting a remedial alternative (40 CFR '300, 400[e][9][iii]). These evaluation criteria serve as the basis for conducting the detailed analyses and selecting an appropriate remedial action.

The first two criteria are minimum, or "threshold," criteria that must be met by all alternatives. The next five criteria are considered "balancing" criteria and are the primary criteria upon which the following analysis is based. The last two, considered to be "modifying" criteria, will not be discussed in this FFS but will be deferred until the public comment process. The nine evaluation criteria, which are defined in the NCP, are described below.

4.1.1 Threshold Criteria

These criteria relate directly to statutory findings that must ultimately be made in the Record of Decision (ROD).

1. Overall Protection of Human Health and the Environment - Under this criterion, the alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short-term and the long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants by eliminating, reducing, or controlling exposures to levels established during the development of remediation goals, consistent with §300.430(e)(2)(i). The assessment for this criterion draws on the assessments of other evaluation criteria, particularly long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

2. Compliance with ARARs - The assessment for this criterion describes how the alternative complies with ARARs, or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered."

4.1.2 Balancing Criteria

Balancing criteria represent the primary criteria upon which the detailed analysis is based.

3. Long-Term Effectiveness and Permanence - Alternatives are assessed for the long-term effectiveness and permanence they provide, along with the degree of certainty that the alternative will prove successful. Factors considered as appropriate include the following:

(a) Magnitude of residual risk remaining from untreated waste or treatment residuals remaining following the conclusion of remedial activities. The characteristics of the residuals should be considered to the degree that they remain hazardous, taking into account their toxicity, mobility, and volume (TMV), and their propensity to bioaccumulate.

(b) Adequacy and reliability of controls that are necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with onsite land disposal for providing long-term protection from residuals, the assessment of the potential need to replace technical components of the alternative, and the potential exposure pathways and risks posed should the remedial action need replacement.

4. Reduction of Toxicity, Mobility, and Volume through Treatment - The degree to which alternatives employ recycling or treatment that reduces TMV is assessed, including how treatment is used to address the principal threats posed by the site. Factors that are considered as appropriate include the following:

(a) The treatment processes employed by the alternatives and the materials they will treat.

(b) The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated.

(c) The degree of expected reduction in TMV of the waste due to treatment and the specification to which reduction(s) are occurring.

(d) The degree to which the treatment is irreversible.

(e) The type and quality of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate hazardous substances and their constituents.

(f) The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

5. Short-Term Effectiveness - The short-term effects of alternatives are assessed considering the following:

(a) Short-term risks that might be posed to the community during implementation of an alternative.

(b) Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.

(c) Potential environmental effects of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

(d) Time until protection is achieved.

6. Implementability - The ease or difficulty of implementing the alternatives is assessed by considering the following types of factors as appropriate:

(a) Technical feasibility, including the technical difficulties and the unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

(b) Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite action).

(c) Availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment, specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and the availability of prospective technologies.

7. Cost - The types of costs that are assessed include the following:

(a) Capital costs, including both direct and indirect costs.

(b) Annual operations and maintenance (O&M) costs.

(c) Net present value of capital and O&M costs.

Detailed cost estimates for the remedial alternatives are presented in **Appendix B**.

4.1.3 Modifying Criteria

These final two criteria will be formally evaluated by the U.S. Environmental Protection Agency at a later date.

8. State (Support Agency) Acceptance - Assessment of state concerns may not be completed until comments on the RI/FS reports are received, but may be discussed, to the extent possible, in the proposed plan issued for public comment. The state concerns that are assessed include the following:

(a) The state's position and key concerns related to the preferred alternative and other alternatives.

(b) The state's comments on ARARs or the proposed use of waivers.

9. Community Acceptance - This assessment includes determining which components of the alternatives that interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received.

4.2 Detailed Analysis of Alternatives

4.2.1 Soil Alternatives

The four alternatives selected for consideration for remediation of the SMS site soils were assessed against the nine evaluation criteria required and defined by the NCP, and a detailed analysis prepared to form a basis for the selection of a final remedial alternative for the SMS site. This approach is designed to provide sufficient information to adequately compare the alternatives and provide the basis for selecting an appropriate remedy for SMS soils pursuant to CERCLA remedy selection requirements.

General descriptions for each alternative considered for remediation are given below. **Section 3** presents descriptions that are more detailed. Detailed analysis of each alternative is presented in **Table 4-1**.

4.2.1.1 Alternative A-1 – No Further Action

The no action alternative constitutes the absence of any remedial actions. No action is considered in this evaluation as a baseline for comparison to all other potential remedial actions, as required by the NCP.

4.2.1.2 Alternative A-2 – Institutional Controls

Institutional controls limit access to the site through fencing, deed restrictions, and signage. Waste is left untreated and in place. O&M will be required for controls such as fence and signs.

4.2.1.3 Alternative A-3 – Onsite Capping/Covering

The onsite cap/cover consists of site grading followed by placement of 2 feet of clay cover overlain by an additional 6 inches of topsoil capable of supporting vegetation. The cover will be seeded to prevent erosion and will require annual O&M to prevent degradation of the cover integrity.

4.2.1.4 Alternative A-4 – Excavation/Treatment/Offsite Disposal

This alternative consists of removing contaminated soil, which will then be treated as necessary and disposed at an offsite landfill. The excavated areas will be backfilled with 2 feet of clean clay and 6 inches of vegetated topsoil.

4.2.2 Sediment Alternatives

The three alternatives selected for consideration for remediation of the SMS site sediment were assessed against the nine evaluation criteria required and defined by the NCP, and a detailed analysis prepared to form a basis for the selection of a final remedial alternative for the SMS site. This approach is designed to provide sufficient information to adequately compare the alternatives and provide the basis for selecting an appropriate remedy for SMS sediment pursuant to CERCLA remedy selection requirements.

General descriptions for each alternative considered for remediation are given below. **Section** 3 provides descriptions that are more detailed. Detailed analysis of each alternative is presented in **Table 4-2**.

4.2.2.1 Alternative B-1 – No Further Action

The no action alternative constitutes the absence of any remedial actions. No action is considered in this evaluation as a baseline for comparison to all other potential remedial actions, as required by the NCP.

4.2.2.2 Alternative B-2 –Monitored Natural Attenuation

Natural attenuation is monitored through sampling events to track concentrations of COCs in the sediment and monitor sedimentation or other processes that may alter those concentrations.

4.2.2.3 Alternative B-3 – Excavation/Treatment/Offsite Disposal

This alternative involves removing contaminated sediments, which will be treated for disposal at an offsite landfill. Excavation will require work in water and will include the appropriate construction methods.

4.3 Comparative Analysis

The comparative analysis evaluates the relative performance of each remedial action alternative for each identified media or area (soils, sediments) relative to threshold and balancing criteria. Modifying criteria (acceptability of state and public) will be evaluated at a later date. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to the others so that key trade-offs that may affect the selection of remedial action alternatives can be identified. The No Action alternative was evaluated to provide a baseline to which other alternatives could be compared, as required by the NCP. Under this alternative, the SMS site and affected offsite areas would be left in their current condition.

The comparative analysis of soil alternatives is presented in **Table 4-1**.

The comparative analysis of sediment alternatives is presented in **Table 4-2**.

5. References

CH2M HILL. 1999. Technical Memorandum. State Marine Superfund Site. Response Action Contract, EPA Region 6. 19 March 1999.

CH2M HILL 2005a. Human Health Risk Assessment. State Marine Superfund Site. Port Arthur, Texas. July.

CH2M HILL 2005b. Baseline Environmental Risk Assessment. State Marine Superfund Site. Port Arthur, Texas. July.

CH2M HILL 2005c. Environmental Risk Assessment Work Plan. State Marine Superfund Site. Port Arthur, Texas.

Engineer's Office, City of Port Arthur, 1998. Untitled 24 X 36 Topographic Map for Pleasure Islet and Vicinity Overlaid onto Post-1974 Aerial Photograph. 1998.

Jefferson County Appraisal District. 1998. Appraisal Map, Sheet 335C, plotted August 17, 1998 Port Arthur, Texas.

Port Arthur Historical Society, 1997. Port Arthur Centennial History (1898-1998), A Pictorial History of Port Arthur, Texas. Looking Glass Media. 1997.

Saez, Louise, U.S. Army Corps of Engineers, Galveston, Texas. 1998. Telephone conversation with P. van Noort. October 13, 1998.

Sample, BE, DM Opresko, and GW Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision.* Oak Ridge National Laboratory, Oak Ridge, TN.

Texas Department of Health (TDH). 1995. EPA Near Coastal Water Grant, Summary of Results and Risk Assessment for Sabine Lake. Texas Department of Health Division of Seafood Safety, March 1995.

Texas Natural Resource Conservation Commission (TNRCC), 1995. *Expanded Site Investigation Report, State Marine of Port Arthur.* HRS Documentation Record, State Marine of Port Arthur. April 1996.

Texas Natural Resource Conservation Commission (TNRCC), 1996. Expanded Site Inspection Report for State Marine of Port Arthur. TXD099801102. Port Arthur, Texas. April.

Texas Natural Resource Conservation Commission (TNRCC), 1998. Preliminary Assessment/Screening Site Inspection Work Plan. Palmer Barge Line, Inc. March 1998.

Texas Natural Resource Conservation Commission (TNRCC), 2001. *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas.* December 2001 RG-263 (revised).

Texas Commission on Environmental Quality (TCEQ), 2005. *Guidelines for the Classification & Coding of Industrial Wastes and Hazardous Wastes.* Waste Permits Division. RG-022 Revised February 2005.

United States Environmental Protection Agency (EPA), 2005. Adult Lead Methodology Frequently Asked Questions (FAQs). http://www.epa.gov/superfund/programs/lead/almfaq.htm

United States Environmental Protection Agency (EPA), 1993. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Fish Sampling and Analysis.* EPA 823-R-93-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

United States Environmental Protection Agency (EPA). 1993. *Wildlife Exposure Factors Handbook,* Volumes I and II. EPA/600/R-93/187a. U.S. Environmental Protection Agency, Office of Research and Development. December.

United States Environmental Protection Agency (EPA), 1999a. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites,* EPA, April 1999, Directive Number 9200.4-17P.

United States Environmental Protection Agency (EPA), 1999b. *Draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.* November 1999.

U.S. Environmental Protection Agency (EPA), 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final.* EPA/540/G-89/004. OSWER Directive 9355.3-01. October 1988.

United States Environmental Protection Agency (EPA), 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final.* EPA 540-R-97-006. June 1997.

Weston Solutions Inc. (Weston), 2000. ESI Report Palmer Barge Line Site, Port Arthur, Jefferson County, Texas. Volume I-ESI Report, EPA. January 2000.

Weston Solutions Inc. (Weston), 2003. Remedial Investigation Report, State Marine Superfund Site, Port Arthur, Jefferson County, Texas. EPA. April 2003.

(This page intentionally left blank.)

Tables

(This page intentionally left blank.)

TABLE 2.1
Potential Contaminant or Chemical-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
Federal	
Clean Air Act (CAA) 40 CFR Part 61	The CAA is the primary federal legislation protecting air quality. National Primary and Secondary Ambient Air Quality Standards (NAAQS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and the New Source Performance Standards (NSPS) are promulgated by EPA under the CAA. Relevant and appropriate to the SMS site.
National Primary and Secondary Air Quality Standards (NAAQS) 40 CFR, Part 50	The NAAQS specify the maximum concentration of a federally regulated air pollutant (i.e., SO_2, particulate matter (PM_{10}), NO_2, CO, ozone, and lead) in an area resulting from all sources of that pollutant. No new construction or modification of a facility, structure or installation may emit an amount of any criteria pollutant that will interfere with the attain-ment or maintenance of a NAAQS (see 40 CFR § 51.160). For the federal NAAQS standards, all measurements of air quality are corrected to a reference temperature of 25EC and to a reference pressure of 760 mm Hg (1,013.2 millibars). May be applicable during the excavation and disposal activities at the SMS site.
American Conference of Governmental Industrial Hygienists-Threshold Limit Values (TLV)	TLVs are based on the development of a time weighted average (TWA) exposure to an airborne contaminant over an 8-hour work day or a 40-hour work week. TLVs identify levels of airborne contaminants at which health risks may be associated. These values are applicable to site works at the SMS site.
American Conference of Governmental Industrial Hygienists-Estimated Limit Values (ELV)	ELVs are based on TLVs and converted to reflect exposure to contaminants on a 24-hour per day basis. The calculation of an ELV does not take into consideration the additive and synergistic effects of contaminants and additional exposures from media other than air. ELVs are not expected to be completely protective of the potential effects of exposures to contaminants; however, they do provide some indication of airborne contaminant levels at which adverse health effects could occur. These values are relevant and appropriate for the SMS site.
Safe Drinking Water Act 40 USC 399 Primary Drinking Water Standards (Maximum Contaminant Levels [MCLs]) 40 CFR Part 141	Establishes MCLs for drinking water. Surface water near the site is not designated for public or private water supply, but may be used for recreational purposes. The shallow ground water at the site is not considered as a drinking water supply source; therefore, MCLs are not applicable to the SMS site.
Maximum Contaminant Level Goals (MCLG)	These levels do not take into account cost or feasibility, and are fully protective of human health. They are only enforceable under CERCLA under specific community water system

TABLE 2.1
Potential Contaminant or Chemical-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
40 CFR Part 141.50	provisions that are not applicable or relevant and appropriate to the SMS site.
Federal Clean Water Act (CWA) Water Quality Criteria 40 CFR Part 131 U.S. EPA Quality Criteria for Water, 1976, 1980, and 1986	These criteria (ambient water quality criteria) apply to water classified as a fisheries resource. Relevant and appropriate to the surface water in Sabine Neches Channel. These criteria are contained in Clean Water Act (CWA) § 303 and 304. As non-enforceable criteria, these criteria are included as to be considered only.
Hazardous Substances 40 CFR Part 116.3 and 116.4	Establishes reporting requirements for certain discharges of reportable quantities of hazardous substances. Creates no substantive clean up requirement. May be relevant and appropriate to the SMS site based on the chosen remedial alternative and if discharges of reportable quantities of hazardous substances occur during implementation of the remedy.
Solid Waste Disposal Act Subtitle C Requirement 40 CFR, Part 264, Subpart F	Governs the maximum concentration of constituents released to ground water from solid waste management units (SWMU). Applicable to the SMS site if the chosen remedy includes onsite disposal and ground water is adversely affected.
Designation of Hazardous Substances 40 CFR, Part 302.4	This section provides tables of the following substances: (a) Listed hazardous substances. The elements and compounds and hazardous wastes appearing in Table 302.4 are designated as hazardous substances under Section 102(a) of CERCLA. (b) Unlisted hazardous substances. A solid waste, as defined in 40 CFR 261.2, which is not excluded from regulation as a hazardous waste under 40 CFR 261.4(b), is a hazardous substance under Section 101(14) of CERCLA if it exhibits any of the characteristics identified in 40 CFR 261.20 through 261.24. Applicable to the SMS site because solid/hazardous wastes were previously disposed at the site and hazardous substances are present in soil and sediment.
Land Disposal Restrictions 40 CFR, Part 268	Establish numerical treatment standards for disposal of hazardous wastes. Potentially applicable if hazardous wastes are identified and offsite disposal is a selected remedy.

TABLE 2.1
Potential Contaminant or Chemical-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
State	
Texas Surface Water Quality Standards 30 TAC 307	Establishes limits for constituents for the protection of surface water quality. Requires the maintenance of the quality of water in the state consistent with public health and enjoyment, propagation and protection of terrestrial and aquatic life, operation of existing industries, and economic development of the state. Applicable for release of COCs from the SMS site into Sabine-Neches Channel.
Hazardous Metals (30 TAC 319, General Regulations Incorporated into Permits, Subchapter B)	Establishes allowable concentrations for discharge of hazardous metals to inland waters (319.22). Potentially applicable for the SMS site as hazardous metals have been detected in soil and sediment samples collected from the site and the hazardous metals may be discharged to waters of the state.
Waste Classification 30 TAC 335, Subchapter R	Establish numerical criteria for designating a waste as a hazardous waste or as one of three classes of solid waste. Applicable for classification of wastes generated during the site remediation.
Texas Risk Reduction Rules 30 TAC 335, Subchapter R	Establishes a three tiered cleanup program with different numerical cleanup standards for each tier for release from SWMUs. Standard 1 is to cleanup to background concentrations. Standards 2 and 3 identify methods for calculating risk-based numerical cleanup levels. Applicable for the SMS site.

TABLE 2.2
Potential Location-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
Federal	
Executive Order on Floodplain Management, Order No. 11988	Requires all federal agencies and associates to avoid long- and short-term adverse impacts associated with occupancy and modification of floodplains. Any actions taken to reduce the risk or impact of remedial actions should accomplish the following: • Reduce the risk of flood loss.

TABLE 2.2
Potential Location-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
	• Minimize the impacts of floods on human safety, health, and welfare. • Restore and preserve the natural and beneficial values served by floodplains. This requirement is applicable only if the site lies within the 100-year floodplain or the remedy impacts a 100-year floodplain. Portions of the SMS site lie within a 100-year floodplain and this order is applicable to the site.
Fish and Wildlife Coordination Act 16 USC § 661 et seq. 16 USC § 742 a 16 USC § 2901	Requires consultation when a modification of a stream or other water body is proposed or authorized and requires adequate provision for protection of fish and wildlife resources. Relevant and appropriate to the SMS site for removal of contaminated sediment from the Sabine-Neches Channel if the remedy requires the contaminated sediment to be removed.
Protection of Wetlands Executive Order No. 11990 40 CFR § 6.302(a) and **Appendix A** Clean Water Act Section 404	Requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practical alternative exists. Applicable to the SMS site because the site is surrounded by environmentally sensitive wetlands.
Endangered Species Act 16 USC § 1531 et. seq. 50 CFR Part 402	Requires that proposed action minimize impacts on endangered species within critical habitats upon which endangered species depend, including consulting with Department of Interior. Endangered or threatened species have not been identified at the site; the Act is not an ARAR for the SMS site.
Coastal Zone Management Act 16 U.S.C 1451	Encourages restoration of natural coastal resources including wetlands, floodplains, estuaries, as well as the fish and wildlife using those habitats. The site is surrounded by environmentally sensitive wetlands and bird rookeries, most of which have been designated as a National Wildlife Refuge. Applicable to the SMS site.
State	
Texas Surface Water Quality Standards (30 TAC Chapter 307)	Applicable because the SMS site is located near Sabine Neches Channel and remedial activities may affect surface waters of the state.

TABLE 2.2
Potential Location-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
Texas Coastal Zone Management Program	Requires that existing regulatory agencies coordinate with the Texas Coastal Zone Management Program when permitting activities in the Texas Coastal Zone. Applicable as the SMS site is located in the Texas Coastal Zone.

TABLE 2.3
Potential Action-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
Federal	
Storm water Regulations 40 CFR Parts 122, 125	National Pollution Discharge Elimination System (NPDES) permits are addressed relative to storm water discharges associated with industrial activity. These regulations require the development and implementation of a storm water pollution prevention plan or a storm water best management plan. Monitoring and reporting requirements for a variety of facilities are outlined. Although runoff from construction activities at the SMS Site would make this an applicable requirement depending on the nature of the remedial action selected, the TCEQ has authority from the EPA to issue TPDES permits for the authorization of storm water discharges.
National Contingency Plan 40 CFR Part 300.430 Baseline Human Health Risk Assessment RI/FS and ROD	Evaluates baseline human health risk as a result of current and potential future site exposures, and establishes contaminant levels in environmental media for protection of public health. Also provides guidelines and requirements for conducting RI/FS and ROD. Applicable to the SMS site.
Exceptions to ARAR Rules CERCLA § 121(d)(4)	Allows EPA to waive compliance with ARARs in six circumstances: 1. The selected action is only part of a total remedial action that will comply with the ARAR requirements when completed. 2. Compliance with the ARAR requirements would present greater health / environmental risks than alternative options.

TABLE 2.3
Potential Action-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
	3. Compliance with the ARAR requirements is "technically impracticable from an engineering perspective. 4. The selected remedy will attain a "standard of performance that is equivalent to an ARAR required standard through use of another method or approach. 5. With respect to a state requirement, the state has not demonstrated consistent application of the requirement in similar circumstances. 6. Where the remedy is to be fund-financed (as opposed to private-party financed), meeting the ARAR standard would not provide balance between the need for cleanup at the site in question considering the amount of fund resources that must be used at other sites in need of cleanup. These provisions are applicable to the SMS site.
Permits and Enforcement CERCLA Section 121(e)	This section specifies that no federal, state, or local permit shall be required for any portion of a CERCLA remedial action that is conducted on the site of the facility being remediated. This includes exemption from the RCRA permitting process. Applicable to the SMS site.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities 40 CFR Part 264 Subparts B, C, D and G	Subparts B, C, and D establish minimum standards that define the acceptable management of hazardous waste for owners and operators of facilities that treat, store, or dispose of hazardous waste. Subpart G establishes standards for closure and post closure care for site design and operation. These standards will be relevant and appropriate to the SMS site if wastes onsite are identified as RCRA hazardous wastes or are sufficiently similar to RCRA hazardous wastes.
Use and Management of Containers Tank Systems 40 CFR Part 264 Subparts I and J	Subpart I sets operating and performance standards for container storage of hazardous waste. These requirements would be relevant and appropriate to the SMS site for containers used for storage of liquids, soil, or other wastes as part of the remedial action. Subpart J outlines similar standards but applies to tanks rather than containers.
Standards for Waste Piles and Landfills 40 CFR Part 264 Subparts L and N	Subpart L sets design and operating requirements for the storage or treatment of wastes in piles. If the waste piles are closed with wastes left in place, Subpart N requirements must be met. Subpart N establishes construction, design, performance, closure, and operation requirements pertaining to hazardous waste landfills. If treatment, storage, or disposal of RCRA waste in piles is included as part of the remedial action, Subpart L and/or N would be relevant and appropriate to the SMS site. Subpart N would be applicable to the SMS site in

TABLE 2.3
Potential Action-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
	the event that hazardous wastes are identified at the site.
Miscellaneous Units 40 CFR Part 264 Subpart X	Relates to "miscellaneous" units that treat, store, or dispose of hazardous wastes. Provides general performance standards for location, design, construction, operation, monitoring, and closure/post closure. If the remedial action includes treatment, storage, or disposal of hazardous waste in a miscellaneous unit, these requirements would be relevant and appropriate to the SMS site.
Land Disposal Restrictions (LDRs) 40 CFR Part 268 Subpart C - Prohibitions on Land Disposal Subpart D - Treatment Standards	40 CFR Part 268 establishes restrictions on land disposal unless treatment standards are met or a "no migration exemption" is granted. LDRs establish prohibitions, treatment standards, and storage limitations before disposal for certain wastes as set forth in Subparts C and D. Treatment standards are expressed as either concentration-based performance standards or as specific treatment methods. Wastes must be treated according to the appropriate standard before wastes or the treatment residuals of wastes may be disposed in or on the land. The Universal Treatment Standards (UTS) establish a concentration limit for 300 regulated constituents in soil regardless of waste type. The LDRs are applicable to the SMS site if hazardous wastes are identified.
Requirements for Identification and Listing of Hazardous Wastes 40 CFR Part 261	These regulations establish the requirements for the identification and listing of hazardous wastes. These requirements are applicable to the SMS site and would require that potential hazardous wastes be tested for identification and listed if appropriate.
Standards Applicable to Generators and Transporters of Hazardous Waste 40 CFR Part 262 and Part 263	Part 262 establishes the record keeping requirements and manifesting requirements for the transport of hazardous wastes. Part 263 establishes requirements for the transport of hazardous wastes. These requirements would be applicable to the SMS site if hazardous wastes are identified and shipped offsite for disposal.
Department of Transportation Requirements Governing the Transportation of Hazardous Materials 49 CFR Parts 107 and 171-179	Establishes the requirements for the transportation of hazardous materials as defined by the U. S. Department of Transportation. These requirements would be applicable to the SMS Site if the hazardous wastes are identified and transported offsite for disposal.
OSHA Worker Protection 29 CFR 1910, 1926 and 1904	Establishes requirements for occupational health and safety applicable to workers engaged in hazardous waste site or CERCLA response actions. Applicable for protection of workers who will be exposed to hazardous substances during remediation at the SMS site.

TABLE 2.3
Potential Action-Specific ARARs
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
State	
Spill Prevention and Control 30 TAC 327	Requires that releases of reportable quantities of listed materials be reported to the agency (TCEQ) within 24 hours. The responsible person shall submit written information, such as a letter, describing the details of the discharge or spill and supporting the adequacy of the response action, to the appropriate TCEQ regional manager within 30 working days of the discovery of the reportable discharge or spill. The regional manager has the discretion to extend the deadline. The rule is applicable to the site if during remedial activities a release greater than the documented reportable quantity of a listed material occurs.
Control of Air Pollution from Visible Emissions and Particulate Matter 30 TAC 111	Requires that all reasonable precautions shall be taken to prevent particulate matter from becoming airborne, including use of water or chemicals for control of dust in the construction operations, clearing of land, and on dirt roads or stockpiles. Applicable during excavation and transport of soils, or any other activity that may generate airborne particulate matter at the SMS Site.
TPDES Construction Storm water Permit 30 TAC 205	Requires submission of Notice of Intent (NOI) for coverage under the general permit for storm water discharges resulting from construction occurring on sites greater than 1 acre in size. This requirement will be applicable to the SMS Site during the site remedial construction.
Texas Industrial Solid Waste and Municipal Solid Waste Regulations 30 TAC 335	Guidelines for generators to determine if a solid waste is a hazardous waste. Requires adherence to recordkeeping and shipping requirements. Applicable to the soils and wastes to be removed at the SMS site, which may or may not be hazardous.

TABLE 2.4
Guidelines to be Considered
State Marine Superfund FFS, Pot Arthur, TX

Requirement	Justification
Federal	
References Doses (RfDs), EPA office of Research and Development	The EPA Office of Research and Development provides non-enforceable toxicity data for specific chemicals for use in public health assessments. This data is used to assess the risks associated with contaminated media at the SMS site.
Risk Specific Doses (RSDs), EPA Carcinogen Assessment Group and EPA Environmental Criteria and Assessment Office	RSDs represent the dose of a chemical in mg/kg of body weight per day associated with a specific risk level (i.e., 10^{-6}). RSDs are determined by dividing the selected risk level by the cancer potency factor (slope factor). This standard is used to assess the risks associated with contaminated media at the SMS site.
USEPA OSWER Directive 9355.3-01, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA	This guidance document provides information regarding the steps and processes necessary to properly conduct RI/FS at CERCLA site. This document is the primary guidance used in the preparation of the FFS.
State	
Texas Risk Reduction Program (TRRP) 30 TAC 350	TRRP establishes the TCEQ's minimum remediation standards for present and past uncontrolled constituent releases. TRRP uses risk evaluation to determine if corrective action is necessary for the protection of human health and the environment and to identify acceptable constituent levels in the impacted media. TRRP defines the land use categories, ground water classifications, requirements for plume management zone, soil reuse issues, and tiered risk evaluation for affected sites. This state regulation is not applicable for the Federal superfund sites but should be considered at the SMS site.

(This page intentionally left blank.)

TABLE 3-1 – ALTERNATIVE SCREENING FOR SOILS
State Marine Superfund Site
Port Arthur, Texas

Alternative	Advantages	Disadvantages	Relative Cost
No Further Action	1. Minimal Cost.	1. Compliance with ARARs would not be achieved. 2. Does not remove contamination that exceeds PRGs. 3. No additional remedial actions are conducted for the site soils to control the exposure pathways to human health and the ecological system.	Minimal
Institutional Controls • Deed Restrictions • Fence or Structure • Signage	1. Limits future uses of the site 2. Limits access to site contaminants that exceed PRGs.	1. Compliance with ARARs would not be achieved. 2. Does not remove contamination that exceeds PRGs. 3. Ongoing industrial operations at the site may be limited by institutional controls	Low
In Situ Treatment • Phytoremediation • Grading • Environmental Monitoring	1. Does not require moving waste offsite. 2. Removes contaminants that exceed PRGs from soil. 3. Compliance with ARARs would be maintained if contaminant concentration levels are relatively low.	1. Completely restricts future industrial use of site until PRGs are met. 2. Grading required to minimize surface water infiltration. 3. May require long term O&M until concentrations are reduced.	Medium
Containment - Soil Cover • Soil Cap/Cover • Grading and Revegetation • Environmental Monitoring	1. Does not require moving waste offsite. 2. Cap can be designed to allow some future use of property.	1. Limits some future industrial use of site. 2. Settling and erosion to cap may occur, requiring routine O&M. 3. Revegetation to prevent erosion on full cap design could be impaired by ongoing site operations. 4. Grading required in order to minimize surface water infiltration. 5. Site conditions need to be evaluated further to establish design parameters for a cap. 6. Compliance with ARARs would not be achieved if the alternative disturbs or destroys sensitive ecological habitat.	Medium to High
Containment - Consolidation w/ Soil Cover • Consolidation of "Hot Spot" Soil • Soil Cap/Cover • Grading and Revegetation • Environmental Monitoring	1. Does not require moving waste offsite. 2. Consolidation with capping can be designed to allow significant future use of property (smaller footprint of capped area than capping without consolidation alternative). 3. Less impact to future use than capping alone. 4. Easier to establish vegetation to limit erosion of cap due to smaller footprint. 5. Contaminated soils can be consolidated away from shoreline, potentially	1. Due to underlying landfill waste, minimum soil cover and slope requirements would still need to be met in areas where COCs > PRGs are removed for consolidation. 2. Some settling and erosion to cap may occur, requiring routine O&M. 3. Site conditions need to be evaluated further to establish design parameters for a cap. 4. Excavation of a portion of underlying municipal landfill waste may be required to meet PRGs when excavating hot spots.	Medium

TABLE 3-1 – ALTERNATIVE SCREENING FOR SOILS
State Marine Superfund Site
Port Arthur, Texas

Alternative	Advantages	Disadvantages	Relative Cost
	minimizing the area of erosion control measures along shoreline.	5. Compliance with ARARs would not be achieved if the alternative disturbs or destroys sensitive ecological habitat.	
Excavation/Treatment/Offsite Disposal • Excavation • Ex-situ Treatment • Offsite Disposal	1. Removal of contaminants that exceed PRGs from site. 2. Once the soils are treated and/or pass the TCLP test, they will no longer be a hazardous waste and can be disposed in a licensed landfill. 3. Low future O&M costs because waste removed from site. 4. Contaminated soils exceeding PRGs could be removed from shoreline areas, potentially minimizing the area of erosion control measures along shoreline.	1. Risk of barge cleaning process contaminants having leaked into landfill waste, would require confirmation sampling. 2. Excavation of a portion of underlying municipal landfill waste may be required to meet PRGs. 3. Compliance with ARARs would not be achieved if the alternative disturbs or destroys sensitive ecological habitat.	Medium to High

TABLE 3-2 – SEDIMENT
State Marine Site - Feasibility Study Alternative Evaluation
Port Arthur, Texas

Alternative	Advantages	Disadvantages	Relative Cost
No Further Action	1. Minimal Cost. 2. Does not disturb existing habitat. 3. Minimizes risk of mobilizing contaminants that exceed PRGs during construction. 4. Does not require moving waste offsite.	1. Compliance with ARARs would not be achieved. 2. Does not remove contaminants that exceed PRGs. 3. No additional remedial actions are conducted for the site sediment to control the exposure pathways to human health and the ecological system.	Minimal
Monitored Natural Attenuation • Fence or Structure • Signage • Monitoring of Natural Attenuation	1. Does not disturb existing habitat. 2. Minimizes risk of mobilizing contaminants that exceed PRGs during construction. 3. Does not require moving waste offsite. 4. Restricts access to site and contaminants exceeding PRGs. 5. Reduces risk of human exposure to contaminants, contaminated media, and reduces disturbances to ecological receptors. 6. Potentially lower overall remediation costs than those associated with active remediation. 7. Can be implemented along with source control remedies for soil.	1. Compliance with ARARs would not be achieved. 2. Does not remove contaminants that exceed PRGs. 3. Longer time frames may be required to achieve remediation objectives, compared to active remediation measures. 4. Potential future remedial action may be required if natural attenuation process does not achieve target PRGs in a timely fashion. 5. Long-term performance monitoring will generally be more extensive and for a longer time.	Low
Containment • Containment Structure (i.e. revetment with granular cover) • Environmental Monitoring	1. Does not require moving waste offsite. 2. Minimizes exposure pathway to sediment contaminants above PRGs	1. Complete loss of existing habitat. 2. Potential to mobilize contaminants to surface water and adjacent sediments during construction process. 3. Site conditions need to be evaluated further to establish design parameters for a cap. 4. Implementation could be difficult due to the potential for underwater debris from former barge cleaning operations and due to dispersed nature of sediment hot spot areas. 5. Compliance with ARARs would not be achieved if the alternative disturbs or destroys sensitive ecological habitat.	Medium to High
Excavation/Offsite Treatment • Excavation • Ex-situ Treatment • Offsite Disposal • Shoreline Erosion control • Environmental Monitoring	1. Removal of contaminants that exceed PRGs from site. 2. Low future routine O&M costs because waste removed from site.	1. Complete loss of existing habitat. 2. Potential to mobilize contaminants to surface water and adjacent sediments during construction process. 3. Compliance with ARARs would not be achieved if the alternative disturbs or destroys sensitive ecological habitat.	Medium to High

(This page intentionally left blank.)

TABLE 4-1 – SOIL ALTERNATIVES ANALYSIS
State Marine Superfund Site Focused Feasibility Study
Port Arthur, TX

	Threshold Criteria		Balancing Criteria				
Detailed Analysis of Alternatives	**1. Overall Protection of Human Health and the Environment**	**2. Compliance with ARARs**	**3. Long-Term Effectiveness and Permanence**	**4. Reduction of Toxicity, Mobility, and Volume Through Treatment**	**5. Short-Term Effectiveness**	**6. Implementability**	**7. Cost [a]**
A-1 – No Further Action	No loss of remaining benefit from existing habitat since there is no disturbance from remedial action. Does not protect human health or the environment since contaminated soils containing COCs > PRGs remain. Does not reduce direct contact to COCs or prevent further migration through soil erosion or infiltration to shallow ground water.	Does not comply with ARARs since COCs > PRGs remain in place at the site.	Does not provide long-term effectiveness or permanence since no remedial action is taken to address COCs > PRGs. Not effective in the long-term since RAOs not achieved.	Does not reduce mobility or volume. Some reduction of toxicity may occur through natural attenuation. Natural attenuation would not be monitored.	Does not change risks to the community (not a public site). Does not pose additional risk to workers (over existing conditions). Environmental impacts are unchanged since COCs > PRGs are not addressed. Not effective in the short-term since RAOs not achieved.	Not Applicable.	Minimal (5 year reviews)
A-2 – Institutional Controls	Minimal disturbance of remaining benefit from existing habitat since there is no disturbance from remedial action. Provides some protection of human health by limiting access to site by fencing soil hot spot areas. Limits future use of the property to commercial/industrial uses and restricts use of ground water through deed restrictions. Does not protect the environment since contaminated soils containing COCs > PRGs remain. Does not prevent further migration through soil erosion or infiltration to shallow ground water.	Does not comply with ARARs since COCs > PRGs remain in place at the site.	Does not provide long-term effectiveness and permanence since COCs > PRGs are not addressed, and magnitude of site risk is not significantly reduced. Institutional controls do not provide long-term effectiveness or permanence for ecological risks. Long-term effectiveness and permanence of institutional controls is dependant on long-term maintenance of fencing.	Does not reduce mobility or volume. Some reduction of toxicity may occur through natural attenuation. Natural attenuation could be monitored.	No change to protection of community (not a public site). Implementation would require minimal disturbance of contaminated media, and therefore pose a minimal risk of exposure to construction workers. Requires only a basic Health & Safety (H&S) Plan and PPE for Protection of workers. No change to environmental impacts of site since COCs > PRGs are not addressed. Short implementation time, but RAOs are not fully achieved (waste left on site).	Deed restrictions and engineering controls (fencing and signage) are easily implemented. No intrusive work. Standard construction techniques would be applied.	Capital Cost $ 204,000 O+M Cost $ 7,000 Total NPV Cost $344,000
A-3 – On-site Soil Cover	Limits future use of the property to commercial/industrial uses and restricts use of ground water through deed restrictions. Provides protection to human health and the environment by limiting the potential for direct contact to soils containing COCs > PRGs. Minimizes transport of COCs through soil erosion and infiltration to shallow ground water. Soil cover visually delineates the soil hot spot areas as well as providing a geotextile separation layer to minimize disturbance from future commercial/industrial uses of the property.	Complies with ARARs by covering COCs > PRGs. Soil cover would comply with minimum cover and slope requirements for municipal landfill closure. Complies with ARARs regarding release to air during remediation through monitoring and engineering controls (air monitoring, dust control). Complies with ARARs regarding release to surface water during remediation through engineering controls (silt fence, berms), treatment, and sampling prior to discharge to surface water.	Magnitude of site risk is adequately reduced by minimizing direct contact and migration of COCs. Provides a reliable physical barrier to direct contact exposure to human and ecological receptors. Requires operation and maintenance to maintain soil cover integrity in order to provide long-term effectiveness and permanence. Potential loss of integrity of soil cover due to disturbance from future industrial activities would increase potential for human exposure to soils. containing COCs > PRGs.	Does not reduce volume of contamination. Some reduction of toxicity may occur through natural attenuation. Soil cover would reduce mobility of COCs by eliminating erosion of contaminated soils and by reducing infiltration of COCs to shallow ground water through improved drainage and a low permeability soil cover.	Some increased risk to community during construction activities due to generation of dust. (Minimal, no residents in close proximity to site). Dust control measures required. Requires a detailed Health & Safety (H&S) Plan, PPE, engineering controls, monitoring, and other safety requirements. (Protection of workers - disturbs COCs during grading process). Short implementation time to meet RAOs. Stormwater treatment and erosion control required to minimize environmental impacts.	Deed restrictions are easily implemented. Soil cover is easily implemented using standard construction equipment and materials. Specialized or proprietary technology is not required. Materials or equipment with limited availability are not required. Underlying landfill waste is not disturbed. Site is readily accessible. Capping is a reliable technology.	Capital Cost $ 878,000 O+M Cost $17,000 Total NPV Cost $1,203,000

TABLE 4-1 – SOIL ALTERNATIVES ANALYSIS
State Marine Superfund Site Focused Feasibility Study
Port Arthur, TX

	Threshold Criteria		Balancing Criteria				
Detailed Analysis of Alternatives	**1. Overall Protection of Human Health and the Environment**	**2. Compliance with ARARs**	**3. Long-Term Effectiveness and Permanence**	**4. Reduction of Toxicity, Mobility, and Volume Through Treatment**	**5. Short-Term Effectiveness**	**6. Implementability**	**7. Cost [a]**
	Requires long term operation and maintenance to maintain integrity of soil cover and overall protectiveness. Provides cover over existing underlying landfill waste. Does not require off-site transport of waste. Loss of remaining benefit from existing habitat due to disturbance from remedial action.	Would require permitting (NPDES/ TPDES). Would comply with OSHA requirements during remedial construction.			Immediate loss of existing habitat due to construction.	Horizontal extents of contamination/capping need to be verified (by sampling) during design.	
A-4 – Excavation/Treatment/Off-site Disposal	Limits future use of the property to commercial/industrial uses and restricts use of ground water through deed restrictions. Provides protection to human health and the environment by removing soils containing COCs > PRGs. Minimizes transport of COCs through soil erosion and infiltration to shallow ground water through removal of soil containing COC > PRGs. Provides cover over existing underlying landfill waste. Long-term operation and maintenance is still required to maintain cover over municipal landfill waste, however overall protection from COCs > PRGs is not dependant on maintaining integrity of the soil cover. Treatment of soils containing COCs > PRGs and disposal in a permitted landfill reduces total risk to human health and the environment. Requires off-site transport of waste materials. Requires more exposure to COCs > PRGs during excavation. Loss of remaining benefit from existing habitat due to disturbance from remedial action.	Complies with ARARs by removing COCs > PRGs. Soil cover would comply with minimum cover and slope requirements for municipal landfill closure. Complies with Land Disposal Restrictions through treatment of hazardous wastes if applicable. Complies with ARARs regarding release to air during remediation through monitoring and engineering controls (air monitoring, dust control). Complies with ARARs regarding release to surface water during remediation through engineering controls (silt fence, berms), treatment, and sampling prior to discharge to surface water. Would require permitting (NPDES/ TPDES). Would comply with OSHA requirements during remedial construction.	Removal of COCs > PRGs is permanent and effective at minimizing risks to human health and the environment. Magnitude of site risk is adequately reduced by minimizing direct contact and migration of COCs through removal as well as through backfill with a low permeability, clean soil cover. Long-term operation and maintenance is not required to provide long-term effectiveness and permanence for COCs > PRGs. Long-term operation and maintenance is only required to maintain soil cover integrity to meet requirements for municipal landfill waste remaining at site. Treatment of soils containing COCs > PRG increases long-term effectiveness and permanence.	Mobility of contamination would be reduced by removal of COC > PRGs from the site. Soil cover would reduce mobility of any remaining COCs < PRGs and from underlying landfill waste by reducing infiltration to shallow ground water through improved drainage and a low permeability soil cover. Treatment of soils to meet land disposal restrictions may reduce mobility and toxicity of COCs. Disposal of soils in a permitted landfill would reduce mobility of COCs through more robust containment measures. Does not reduce volume of contamination. Volume of contaminated media may increase if solidification/stabilization is required to treat waste.	Some increased risk to community during construction activities due to generation of dust. (Minimal, no residents in close proximity to site). More intrusive work during excavation & sampling. Requires a Health & Safety (H&S) Plan, PPE, engineering controls, monitoring, and other safety requirements. (Protection of workers - disturbs COCs during excavation process). Short timeframe to achieve RAOs. Requires hauling of contaminated soils on public roads to treatment/disposal facility. Stormwater treatment and erosion control required to minimize environmental impacts.	Deed restrictions are easily implemented. Soil backfill is easily implemented using standard construction equipment and materials. Specialized or proprietary technology is not required. Materials or equipment with limited availability are not required. Underlying landfill waste is not disturbed. Site is readily accessible. Technology is easy to apply. Excavation may proceed down to landfill waste. Requires confirmation sampling to determine extent that COCs are removed. May present difficulties verifying that all COCs have been fully removed due to existence of landfill waste. Horizontal extents of contamination/capping need to be verified (by sampling) during design.	Capital Cost $2,107,000 O+M Cost $17,000 Total NPV Cost $2,432,000
Comparative Analysis of	No Further Action does not provide protection of human health or	No Further Action does not comply	No Further Action does not provide long term effectiveness or	No Further Action does not reduce	No Further Action – N/A.	No Further Action – N/A.	See

TABLE 4-1 – SOIL ALTERNATIVES ANALYSIS
State Marine Superfund Site Focused Feasibility Study
Port Arthur, TX

	Threshold Criteria		Balancing Criteria				
Detailed Analysis of Alternatives	**1. Overall Protection of Human Health and the Environment**	**2. Compliance with ARARs**	**3. Long-Term Effectiveness and Permanence**	**4. Reduction of Toxicity, Mobility, and Volume Through Treatment**	**5. Short-Term Effectiveness**	**6. Implementability**	**7. Cost [a]**
Alternatives	environment. Institutional Controls provide some protection for human health but no protection for environment. Soil cover provides adequate protection by eliminating the direct contact pathway and mobility. Excavation provides highest level of protection for human health and environment by removing COCs from site and treating them to meet LDRs, and provides clean cover over existing landfill waste.	with ARARs. Institutional Controls does not comply with ARARs. Soil Cover complies with ARARs. Excavation complies with ARARs.	permanence. Institutional Controls provide minimal effectiveness for human health, none for ecological receptors (environment). Soil cover provides long term effectiveness and permanence provided operations and maintenance are ongoing. Excavation provides highest degree of effectiveness and permanence due to the removal (and treatment) of COCs.	TMV. Institutional Controls does not reduce TMV. Soil cover reduces mobility. Excavation reduces mobility and toxicity, but could increase volume if S/S is implemented.	Institutional Controls provides minimal effectiveness. Soil cover easily mitigates risks to workers and community and achieves RAOs in a short time. Excavation easily mitigates risks to workers and community and achieves RAOs in a short time, but increases risk due to offsite transport and provides a slightly higher risk to workers during construction than capping.	Institutional Controls are easily implemented. Soil cover is easily implemented using standard construction methods. Excavation easily implemented using standard construction methods. This alternative is somewhat more complex than capping due to the existence of landfill waste and treatment requirements to dispose excavated materials.	above.

a. Costs rounded to nearest thousand.

TABLE 4-2 – SEDIMENT ALTERNATIVES ANALYSIS
State Marine Superfund Site Focused Feasibility Study
Port Arthur, TX

	Threshold Criteria		Balancing Criteria				
Detailed Analysis of Alternatives	**1. Overall Protection of Human Health and the Environment**	**2. Compliance with ARARs**	**3. Long-Term Effectiveness and Permanence**	**4. Reduction of Toxicity, Mobility, and Volume Through Treatment**	**5. Short-Term Effectiveness**	**6. Implementability**	**7. Cost [a]**
B-1 – No Further Action	There will be no loss of remaining benefit from existing habitat since there is no disturbance from remedial action. Does not protect human health or the environment since contaminated soils containing COCs > PRGs remain. Does not direct contact to COCs or prevent further migration through sediment transport or infiltration to shallow ground water.	Does not comply with ARARs since COCs > PRGs remain in place at the site.	Does not provide long-term effectiveness or permanence since no remedial action is taken to address COCs > PRGs. Not effective in the long-term since RAOs not achieved.	Does not reduce mobility or volume. Some reduction of toxicity may occur through natural attenuation. Natural attenuation would not be monitored.	Does not change risks to the community (not a public site). Does not pose a risk to workers (no remedial action construction activities). Environmental impacts are unchanged since COCs > PRGs are not addressed. Not effective in the short-term since RAOs not achieved.	Not Applicable.	Minimal (5 year reviews).
B-2 –Monitored Natural Attenuation (MNA)	Minimal disturbance of remaining benefit from existing habitat since there is no disturbance from remedial action. Provides some protection of human health by limiting access to site. Limits future use of the property to commercial/industrial uses and restricts use of ground water through deed restrictions. Does not protect the environment since contaminated sediments containing COCs > PRGs remain. Does not prevent further migration through sediment transport or infiltration to shallow ground water.	Does not comply with ARARs since COCs > PRGs remain in place at the site.	Does not provide long-term effectiveness and permanence since COCs > PRGs are not addressed. Magnitude of site risk is not significantly reduced. Institutional controls do not provide long-term effectiveness or permanence for ecological risks. Long-term effectiveness and permanence of institutional controls is dependant on long-term maintenance. MNA provides some verification of long term conditions.	Does not reduce mobility or volume. Some reduction of toxicity may occur through natural attenuation.	No change to protection of community (not a public site). Implementation would require minimal disturbance of contaminated media, and therefore pose a minimal risk of exposure to construction workers. Requires only a basic Health & Safety (H&S) Plan and PPE for Protection of workers. No change to environmental impacts of site. Short implementation time, but RAOs are not fully achieved (waste left on site).	Deed restrictions and engineering controls (such as fencing or signage) are easily implemented. No intrusive work. Standard construction techniques would be applied. Potential for issues with boating access.	Capital Cost $ 76,000 O+M Cost $ 6,000 Total NPV Cost $286,000
B-3 – Excavation/Treatment/Off-site Disposal	Limits future use of the property to commercial/industrial uses and restricts use of ground water through deed restrictions. Provides protection to human health and the environment by removing sediment containing COCs > PRGs. Minimizes transport of COCs from sediment through removal of sediment containing COCs > PRGs. Treatment of sediment containing COCs > PRGs and disposal in a permitted landfill reduces total risk to human health and the environment. Requires off-site transport of waste materials. Requires more exposure to COCs >	Complies with ARARs by removing COCs > PRGs. Complies with Land Disposal Restrictions through treatment of hazardous wastes if applicable. Complies with ARARs regarding release to surface water during remediation through engineering controls (silt fence, berms), treatment, and sampling prior to discharge to surface water. Would require permitting (NPDES/ TPDES). Would comply with OSHA requirements during remedial construction.	Removal of COCs > PRGs is permanent and effective at minimizing risks to human health and the environment. Magnitude of site risk is adequately reduced by minimizing direct contact and migration of COCs through removal. Long-term operation and maintenance is not required to provide long-term effectiveness and permanence for COCs > PRGs. Treatment of sediment containing COCs > PRG increases long-term effectiveness and permanence	Mobility of contamination would be reduced by removal of COC > PRGs from the site. Treatment of sediment to meet land disposal restrictions would reduce mobility and toxicity of COCs. Disposal of sediment in a permitted landfill would reduce mobility of COCs through more robust containment measures. Does not reduce volume of contamination. Volume of contaminated media may increase if solidification/stabilization is required to treat waste. Potential temporary increase in mobility due to sediment disturbance	More intrusive work during excavation & sampling. Requires a detailed H&S Plan, PPE, engineering controls, monitoring, and other safety requirements. (Protection of workers - disturbs COCs during excavation process). Short timeframe to achieve RAOs. Requires hauling of contaminated soils on public roads to treatment/disposal facility. Short term increase in risk to environment during construction due to disturbance of sediments, and potential for mobilization of COCs to Sabine Lake.	Deed restrictions are easily implemented. May require specialized or proprietary technology & equipment. Does not disturb landfill waste. Technology may be difficult to apply, requires preventative measures for work in water to reduce sediment transport during construction. Requires confirmation sampling to determine extent that COCs are removed. Horizontal extents of contamination need to be verified (by sampling)	Capital Cost $1,524,000 O+M Cost $0,000 Total NPV Cost $1,524,000

TABLE 4-2 – SEDIMENT ALTERNATIVES ANALYSIS
State Marine Superfund Site Focused Feasibility Study
Port Arthur, TX

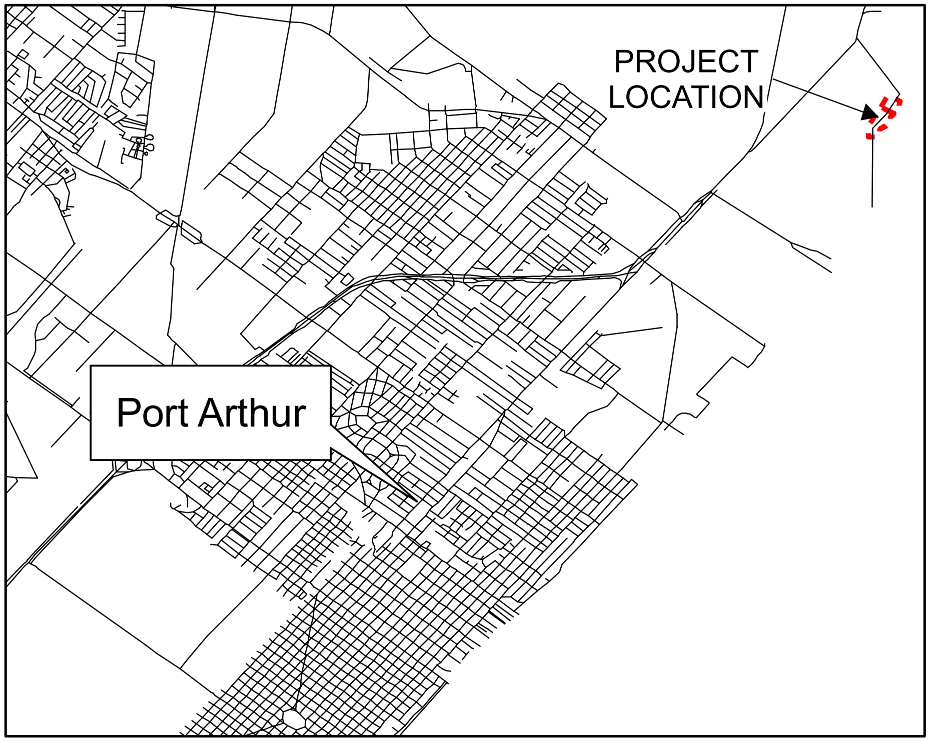
	Threshold Criteria		Balancing Criteria				
Detailed Analysis of Alternatives	**1. Overall Protection of Human Health and the Environment**	**2. Compliance with ARARs**	**3. Long-Term Effectiveness and Permanence**	**4. Reduction of Toxicity, Mobility, and Volume Through Treatment**	**5. Short-Term Effectiveness**	**6. Implementability**	**7. Cost [a]**
	PRGs during excavation. Loss of remaining benefit from existing habitat due to disturbance from remedial action.			during construction.		during design.	
Comparative Analysis of Alternatives	No Further Action does not provide protection of human health or environment. Institutional Controls provide some protection for human health but no protection for environment. Excavation provides highest level of protection for human health and environment by removing COCs from site and treating them to meet LDRs.	No Further Action does not comply with ARARs. Institutional Controls does not comply with ARARs. Excavation complies with ARARs.	No Further Action does not provide long term effectiveness or permanence. Institutional Controls provide minimal effectiveness for human health, none for ecological receptors (environment). Excavation provides highest degree of effectiveness and permanence due to the removal (and treatment) of COCs.	No Further Action does not reduce TMV. Institutional Controls does not reduce TMV. Excavation reduces mobility and toxicity, but could increase volume if S/S is implemented.	No Further Action – N/A. Institutional Controls provides minimal effectiveness. Excavation mitigates risks to workers and community and achieves RAOs in a short time, but increases risk due to offsite transport and provides a slightly higher risk to workers during construction.	No Further Action – N/A. Institutional Controls are easily implemented. Excavation is most difficult to implement due to in-water construction. This alternative is more complex than others due to treatment requirements to dispose excavated materials.	See above.

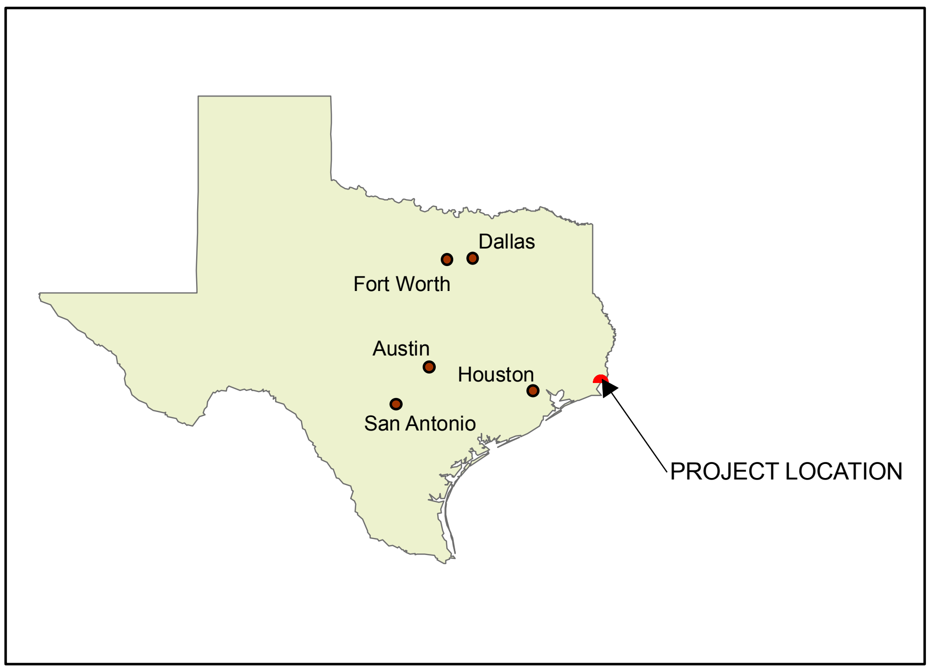
a. Costs rounded to the nearest thousand.

(This page intentionally left blank.)

Figures

(This page intentionally left blank.)





LEGEND

- - - Property Boundary

—— Streets

N

200 100 0 200

SCALE IN FEET

Figure 1-1
Site Location Map

State Marine
Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\FIG_1-1.mxd DATE: 7/13/2005

005684

(This page intentionally left blank.)

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Intertidal Area
- Nearshore Area
- Offshore Area

N

200 100 0 200

SCALE IN FEET

Figure 1-2
1998 Aerial Photograph
Current Site Features Map

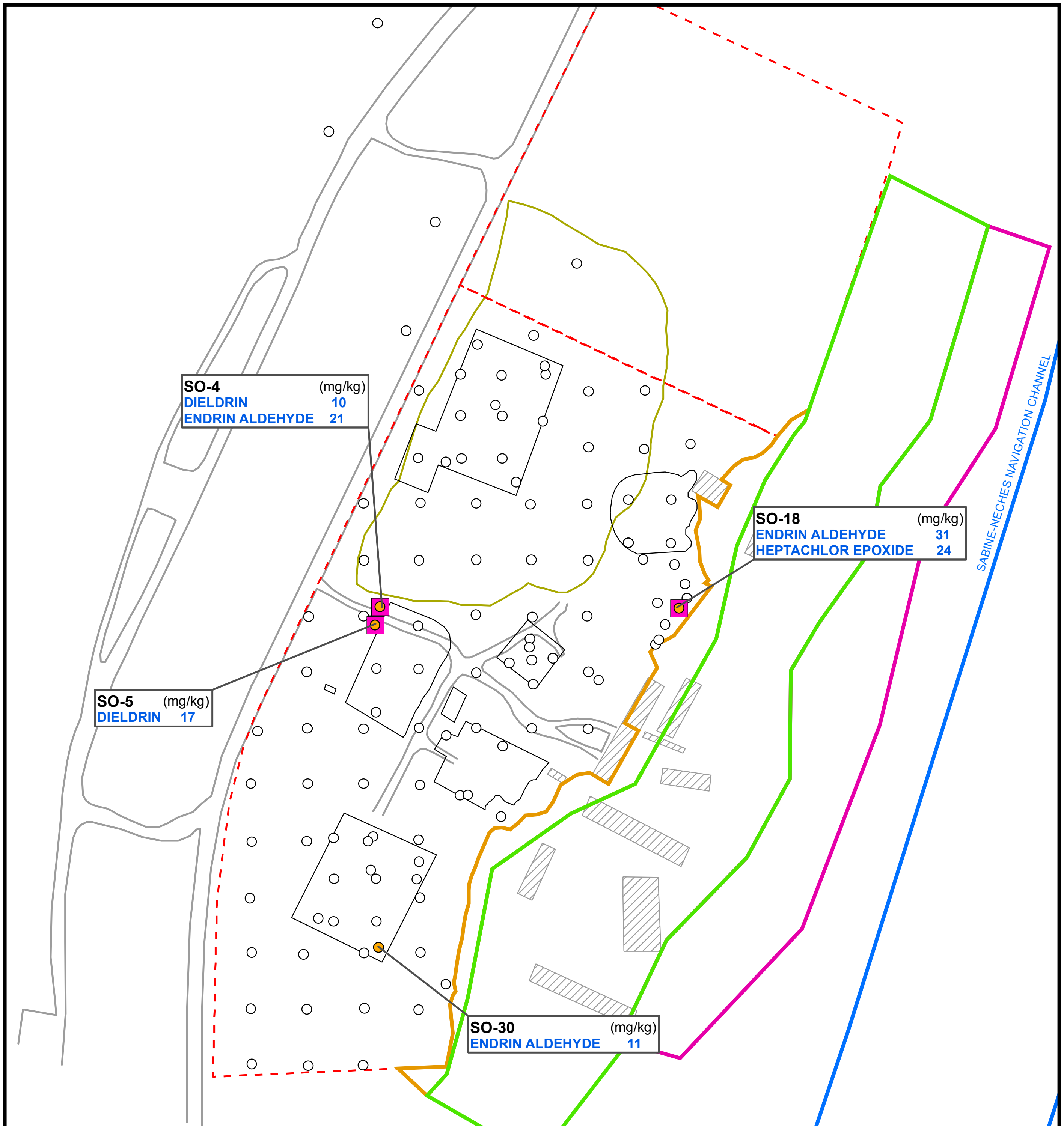
State Marine
Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\FIG_1-2.mxd DATE: 7/13/2005

005686

(This page intentionally left blank.)



PARAMETER	HUMAN HEALTH PRG VALUE	ECOLOGICAL PRG VALUE
DIELDRIN	1.2 mg/kg	0.354 mg/kg
ENDRIN ALDEHYDE		0.207 mg/kg
HEPTACHLOR EPOXIDE	2.1 mg/kg	0.835 mg/kg

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Soil Samples that Do Not Exceed any PRG Criteria
- Soil Samples that Exceed the Ecological PRG Criteria
- Soil Samples that Exceed the Human Health PRG Criteria
- Intertidal Area
- Nearshore Area
- Offshore Area

Note:
Text within labels that is Blue Exceeds the PRG for that Criteria.
The Dieldrin concentrations at Soil Samples SO-4 and SO-5 exceed both Human Health and Ecological PRGs.
The Heptaclor Epoxide concentration at Soil Sample S0-18 exceeds both Human Health and Ecological PRGs.

N

300 150 0 300

SCALE IN FEET

Figure 2-1
Distribution of Soil Samples Exceeding Human Health and Ecological PRGs

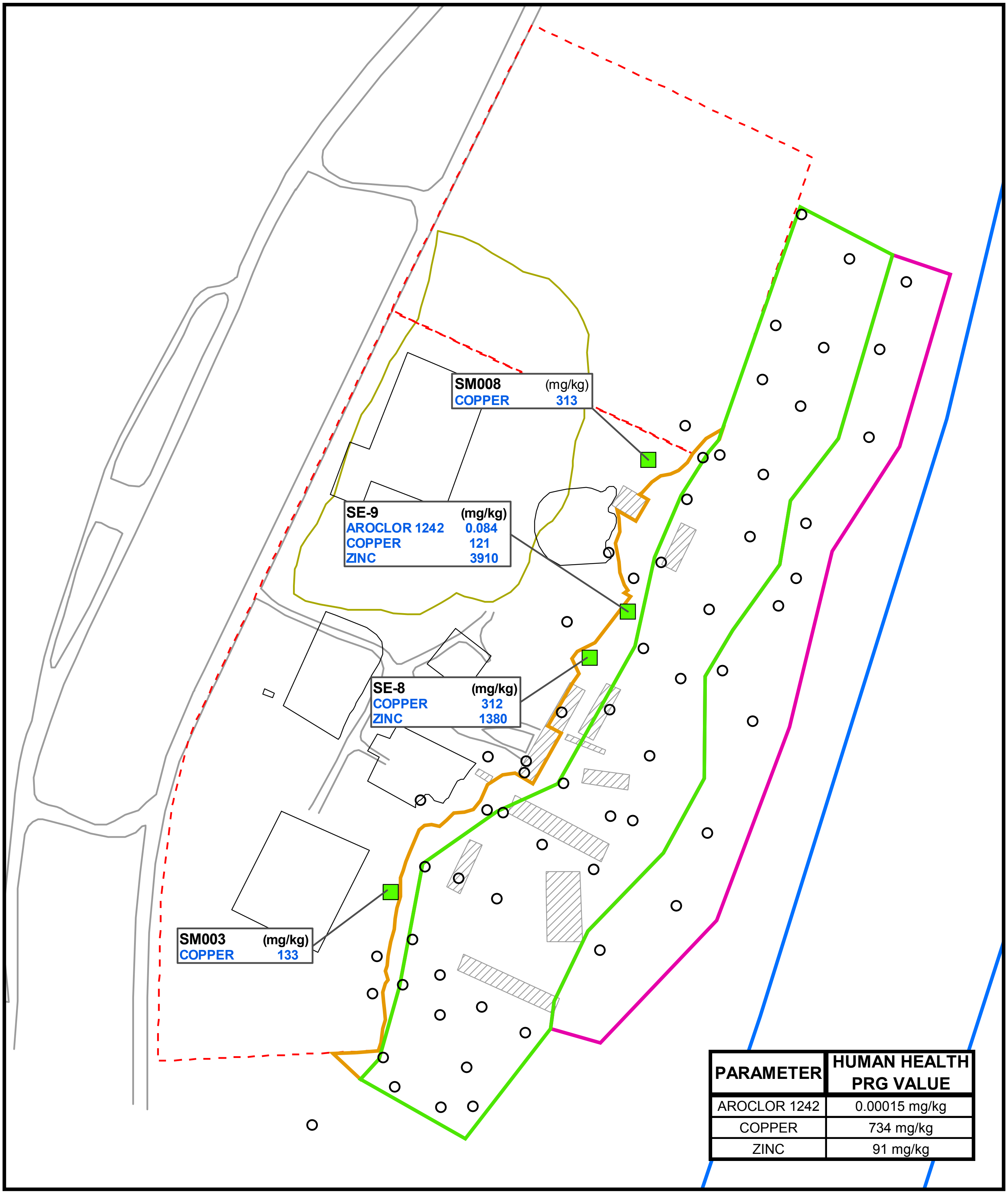
State Marine
Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Soil_PRG_Exceed_overall.mxd DATE: 7/7/2005

005688

(This page intentionally left blank.)



PARAMETER	HUMAN HEALTH PRG VALUE
AROCLOR 1242	0.00015 mg/kg
COPPER	734 mg/kg
ZINC	91 mg/kg

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Sediment Samples that Do Not Exceed PRG Criteria
- Sediment Samples that Exceed the Human Health PRG Criteria
- Intertidal Area
- Nearshore Area
- Offshore Area

Note:
Text within labels that is Blue Exceeds the PRG for that Criteria.

Figure 2-2
Distribution of Sediment Samples that Exceed Human Health PRGs

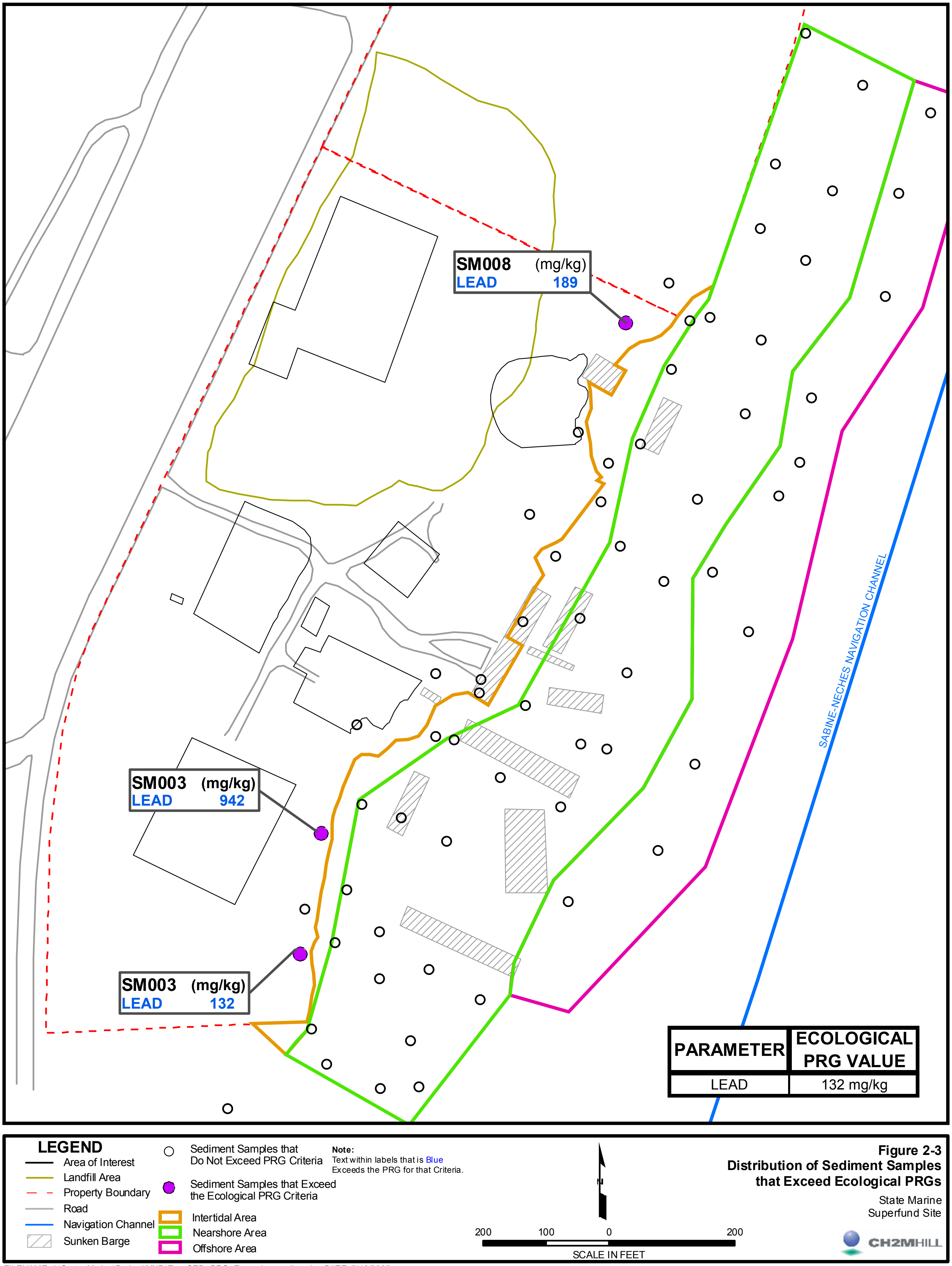
State Marine Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\PRG_Exceed_overall.mxd DATE: 7/12/2005

005690

(This page intentionally left blank.)



PARAMETER	ECOLOGICAL PRG VALUE
LEAD	132 mg/kg

Figure 2-3
Distribution of Sediment Samples that Exceed Ecological PRGs

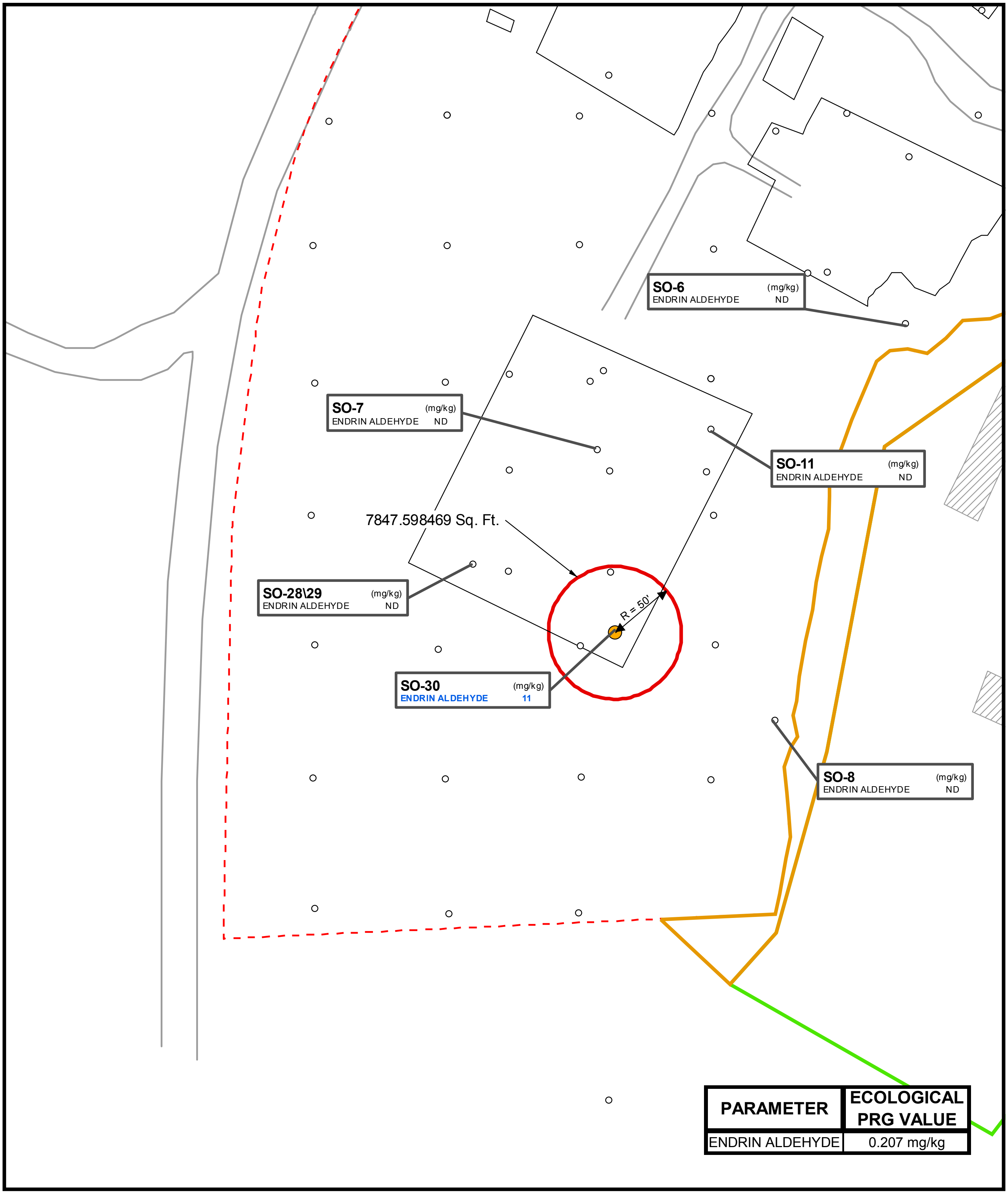
State Marine Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Eco_SED_PRG_Exceed_overall.mxd DATE: 7/13/2005

005692

(This page intentionally left blank.)



PARAMETER	ECOLOGICAL PRG VALUE
ENDRIN ALDEHYDE	0.207 mg/kg

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Soil Samples that Do Not Exceed PRG Criteria
- Soil Samples that Exceed Ecological PRG Criteria
- Intertidal Area
- Nearshore Area
- Offshore Area
- Buffer Around Hot Spot Area

Note:
Text within labels that is Blue Exceeds the PRG for that Criteria.
ND = NON DETECT

N

100 50 0 100
SCALE IN FEET

Figure 2-4
Areas and Volumes of Soils Exceeding PRGs: Hot Spot Area 1

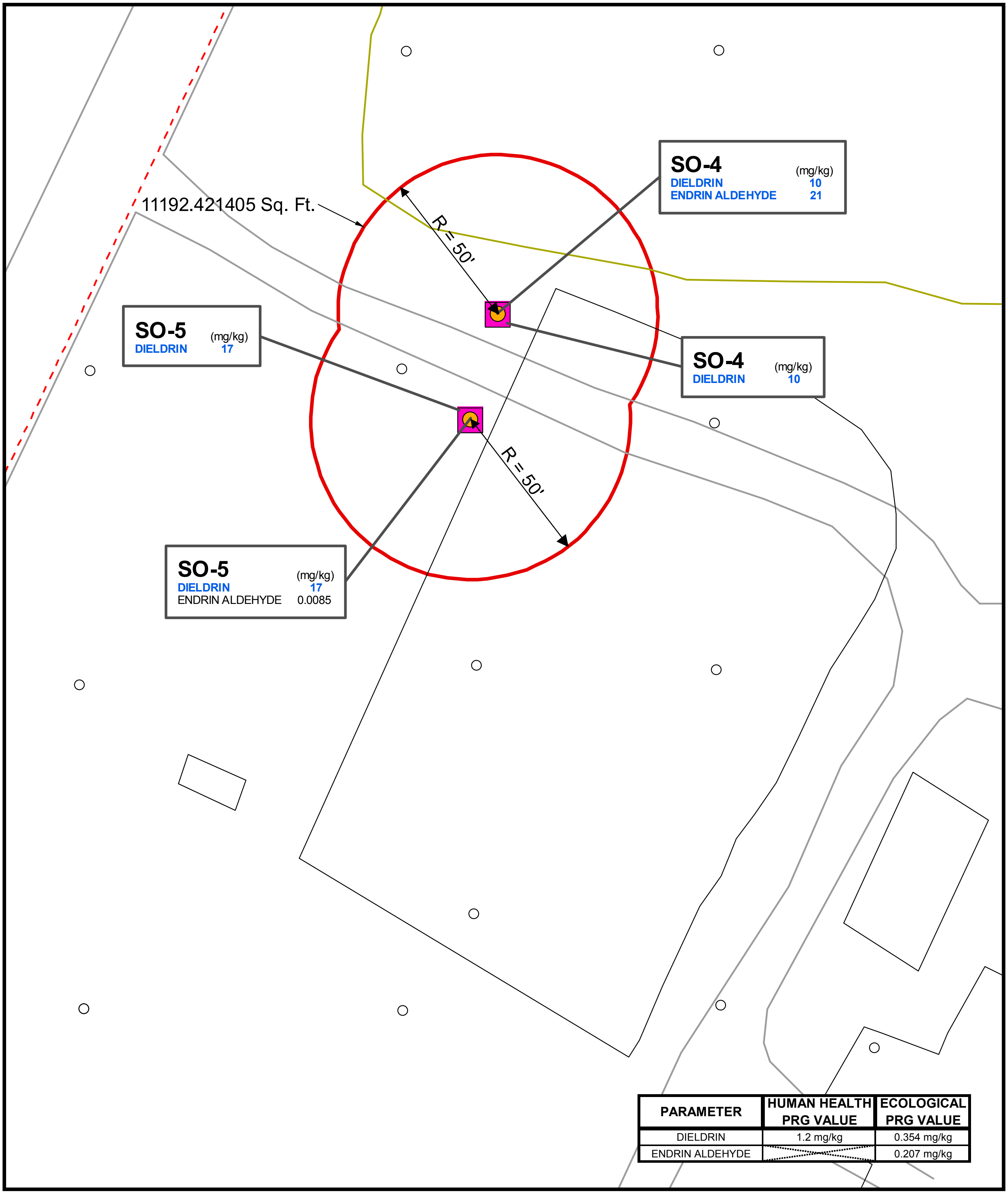
State Marine Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Soil_PRG_Exceed_Area1.mxd DATE: 7/8/2005

005694

(This page intentionally left blank.)



PARAMETER	HUMAN HEALTH PRG VALUE	ECOLOGICAL PRG VALUE
DIELDRIN	1.2 mg/kg	0.354 mg/kg
ENDRIN ALDEHYDE		0.207 mg/kg

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Soil Samples that Do Not Exceed PRG Criteria
- Soil Samples that Exceed the Ecological PRG Criteria
- Soil Samples that Exceed the Human Health PRG Criteria
- Buffer Around Hot Spot Area

Note:
Text within labels that is Blue Exceeds the PRG for that Criteria.
The Dieldrin concentrations at Soil Samples SO-4 and SO-5 exceed both Human Health and Ecological PRGs.
ND = NON DETECT

N

50 25 0 50
SCALE IN FEET

Figure 2-5
Areas and Volumes of Soils Exceeding PRGs: Hot Spot Area 2

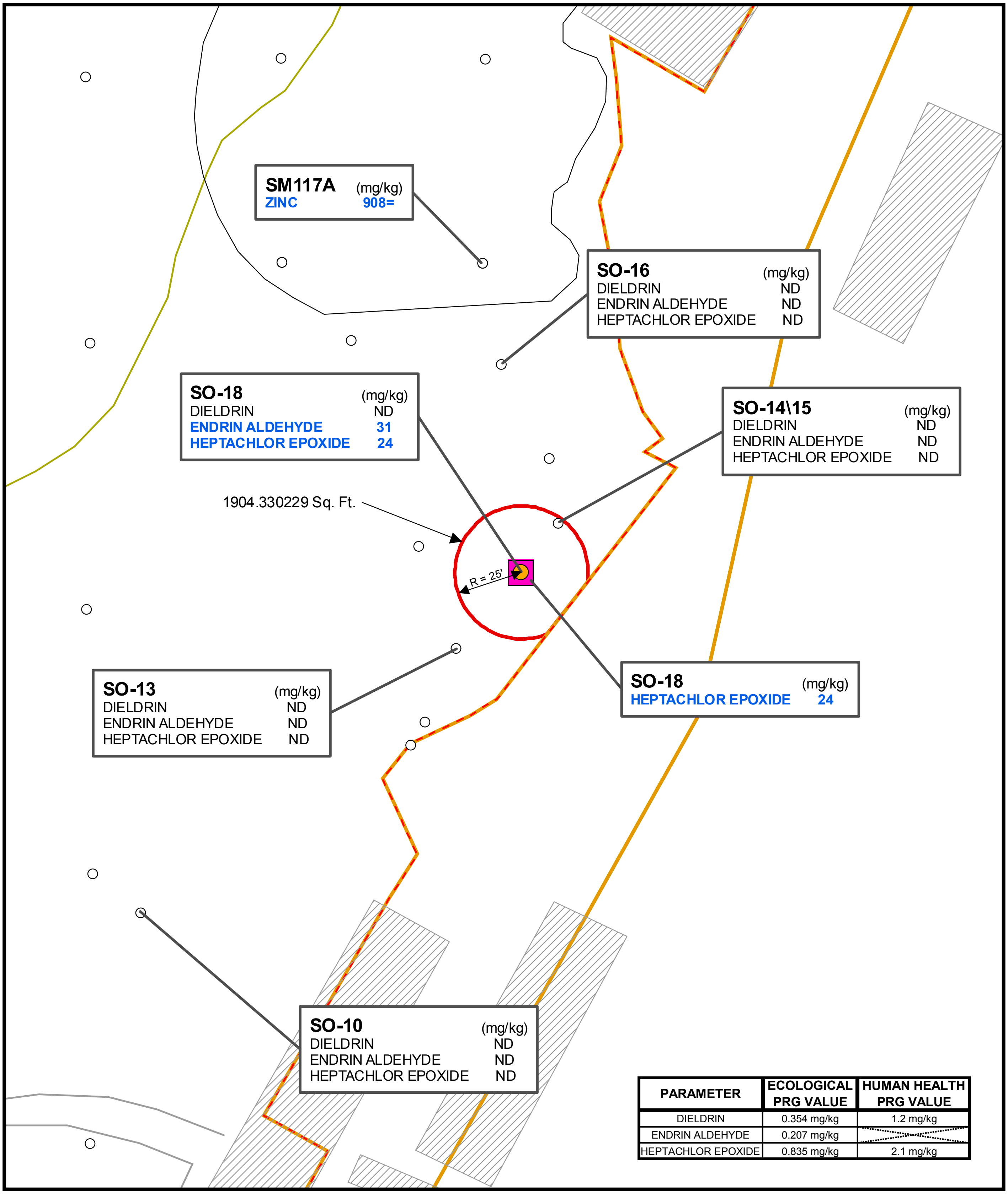
State Marine
Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Soil_PRG_Exceed_Area2.mxd DATE: 7/12/2005

005696

(This page intentionally left blank.)



PARAMETER	ECOLOGICAL PRG VALUE	HUMAN HEALTH PRG VALUE
DIELDRIN	0.354 mg/kg	1.2 mg/kg
ENDRIN ALDEHYDE	0.207 mg/kg	
HEPTACHLOR EPOXIDE	0.835 mg/kg	2.1 mg/kg

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Soil Samples that Do Not Exceed PRG Criteria
- Soil Samples that Exceed the Ecological PRG Criteria
- Soil Samples that Exceed the Human Health PRG Criteria
- Intertidal Area
- Nearshore Area
- Offshore Area
- Foot Buffer Around Hot Spot Area

Note:
Text within labels that is Blue Exceeds the PRG for that Criteria.
The Heptaclor Epoxide concentration at Soil Sample S0-18 exceeds both Human Health and Ecological PRGs.
ND = NON DETECT

N

50 25 0 50
SCALE IN FEET

Figure 2-6
Areas and Volumes of Soils Exceeding PRGs: Hot Spot Area 3

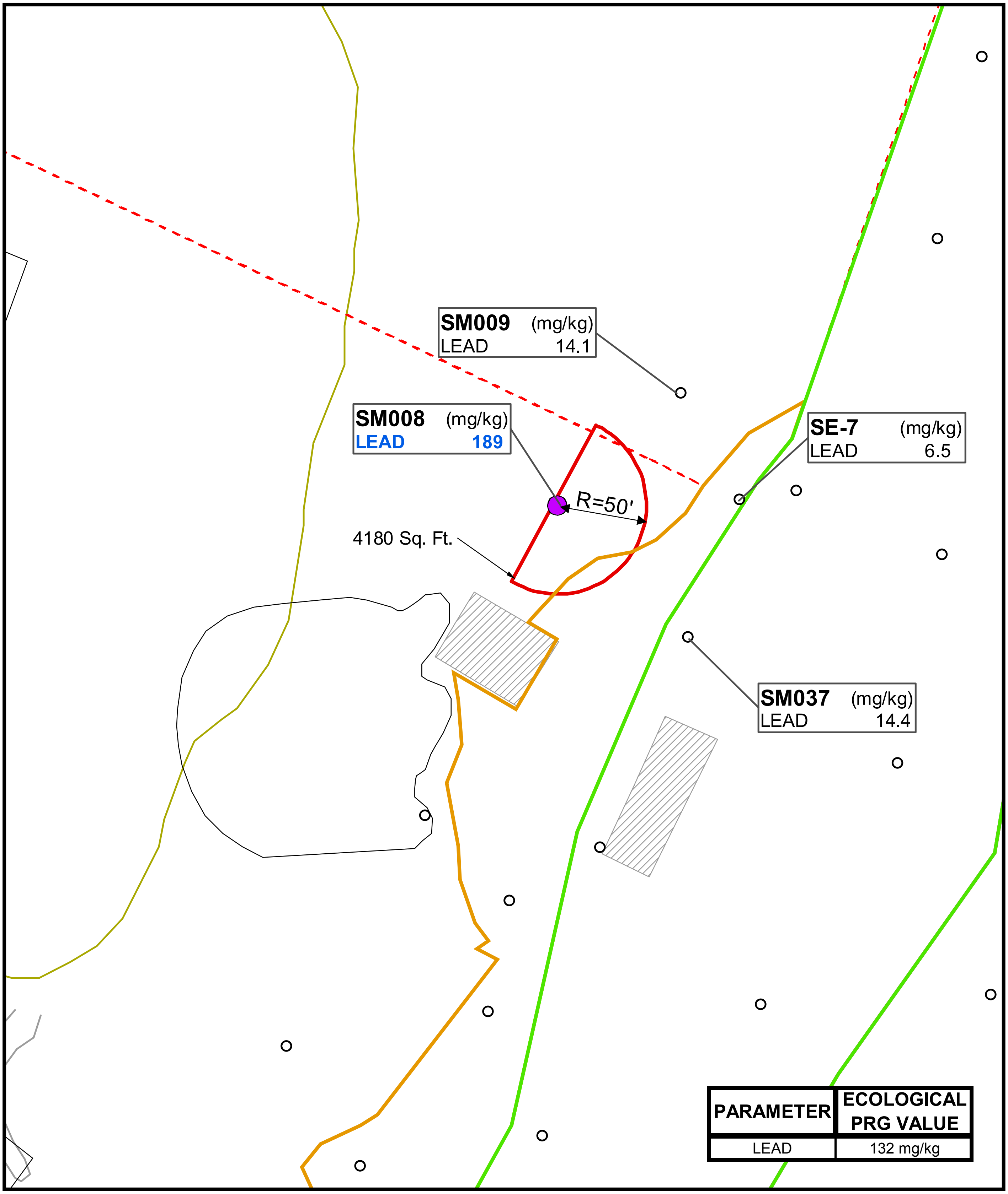
State Marine
Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Soil_PRG_Exceed_Area3.mxd DATE: 7/12/2005

005698

(This page intentionally left blank.)



PARAMETER	ECOLOGICAL PRG VALUE
LEAD	132 mg/kg

LEGEND

- Area of Interest
- Landfill Area
- Property Boundary
- Road
- Navigation Channel
- Sunken Barge
- Sediment Samples that Do Not Exceed PRG Criteria
- Sediment Samples that Exceed the Ecological PRG Criteria
- Buffer Around Hot Spot Area
- Intertidal Area
- Nearshore Area
- Offshore Area

Note:
Text within labels that is Blue Exceeds the PRG for that Criteria.

N

100 50 0 100
SCALE IN FEET

Figure 2-7
Areas and Volumes of Sediment Exceeding PRGs
State Marine Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Eco_SED_PRG_Exceed_AREA1.mxd DATE: 7/13/2005

005700

(This page intentionally left blank.)

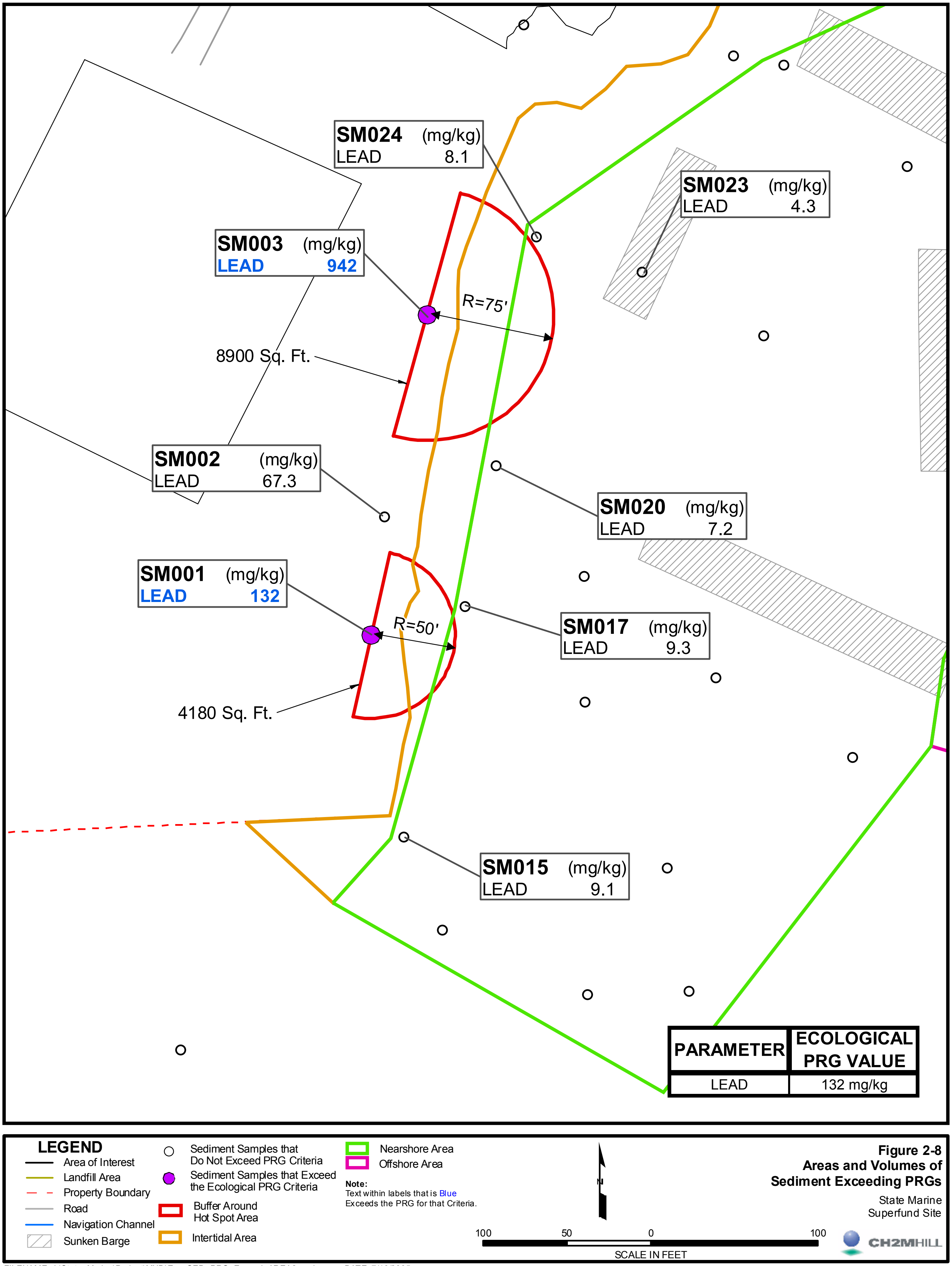


Figure 2-8
Areas and Volumes of Sediment Exceeding PRGs
State Marine Superfund Site

FILENAME: J:\State_Marine\Project\MXD\Eco_SED_PRG_Exceed_AREA2.mxd DATE: 7/13/2005

005702

(This page intentionally left blank.)

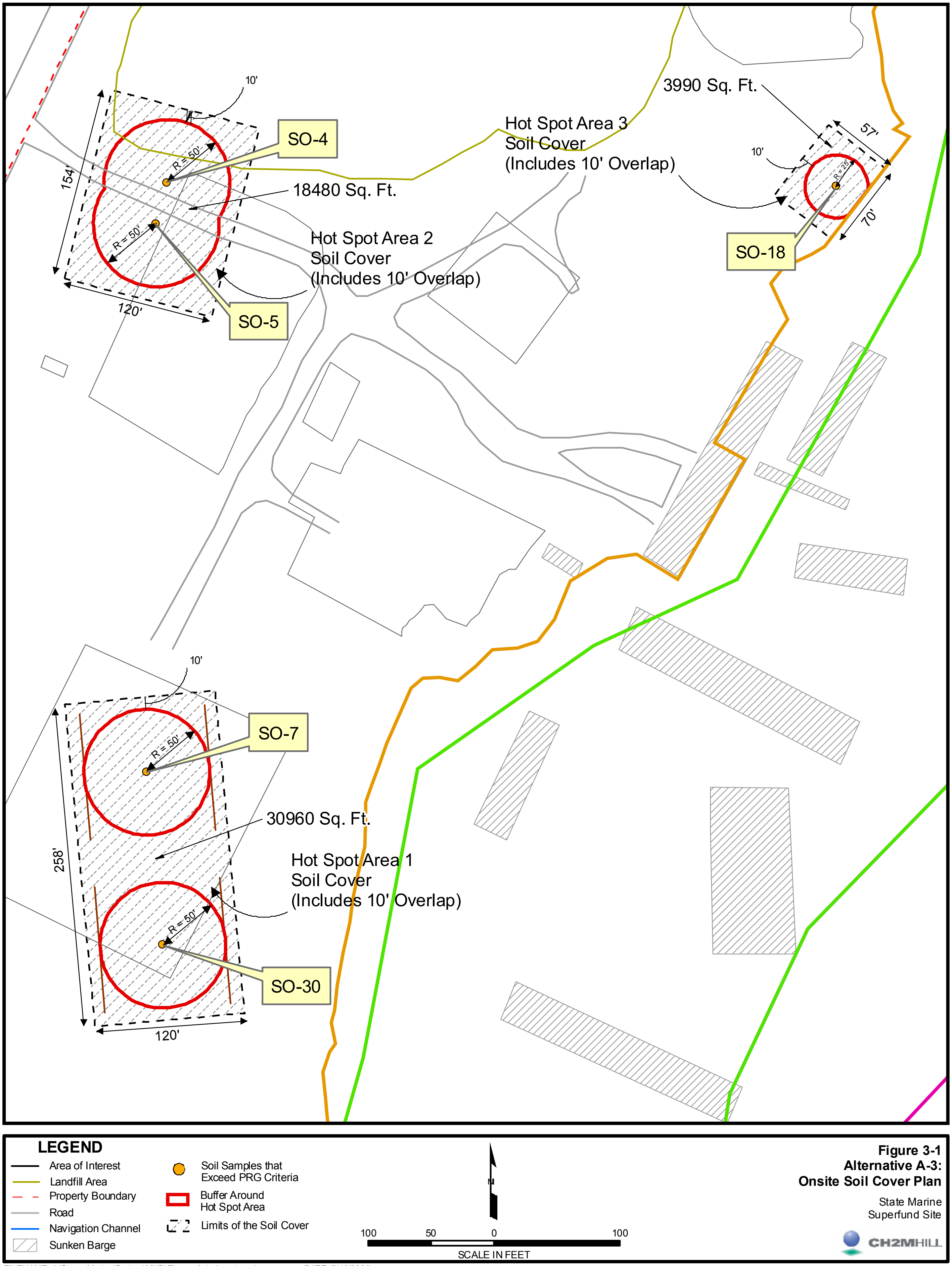


Figure 3-1
Alternative A-3:
Onsite Soil Cover Plan

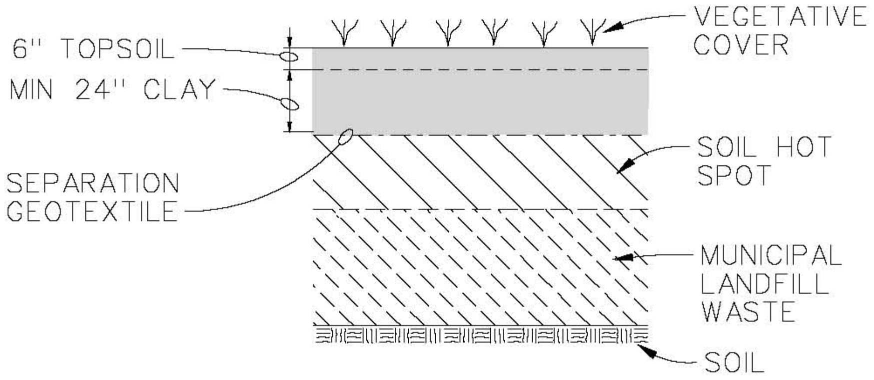
State Marine
Superfund Site

CH2MHILL

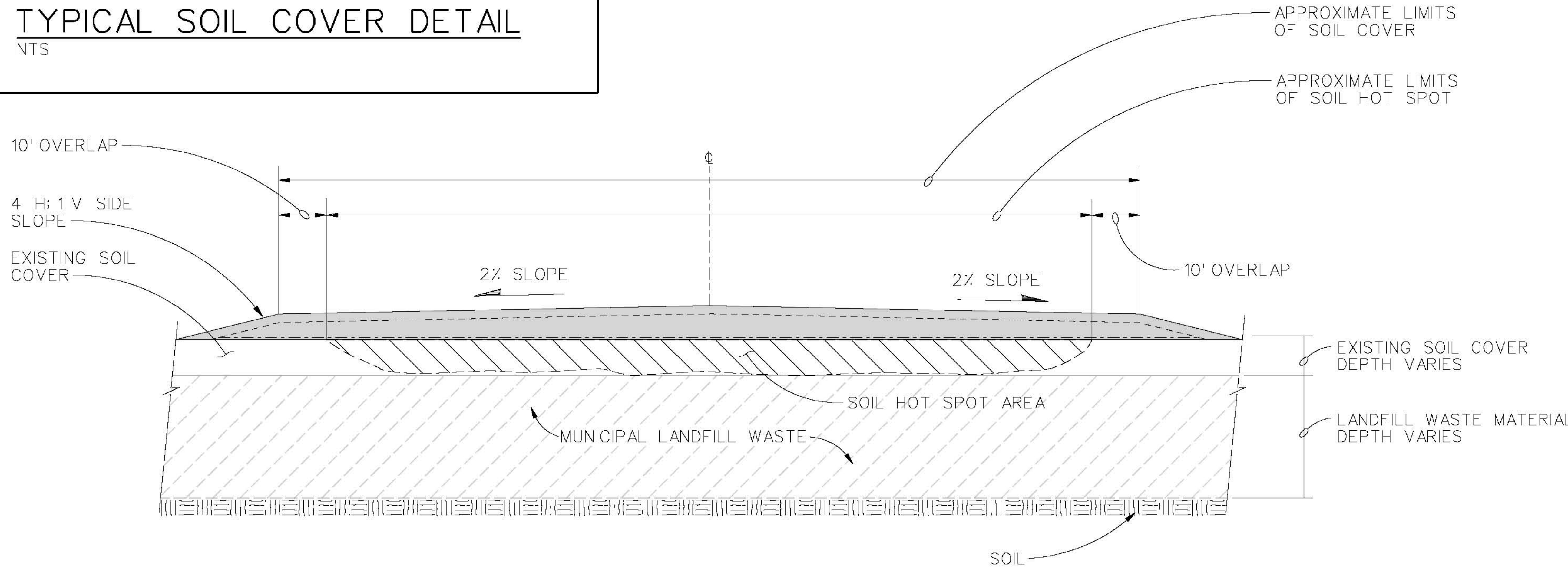
FILENAME: J:\State_Marine\Project\MXD\Figure_3-1_Area1.mxd DATE: 7/13/2005

005704

(This page intentionally left blank.)



TYPICAL SOIL COVER DETAIL
NTS



TYPICAL SOIL COVER SECTION
NTS

FIGURE 3-2
ALTERNATIVE A-3 : TYPICAL SOIL COVER SECTION
STATE MARINE SUPERFUND SITE
PORT ARTHUR TEXAS

CH2MHILL

331756
state marine_cap section.dgn 13-JUL-2005 19:39:33

(This page intentionally left blank.)

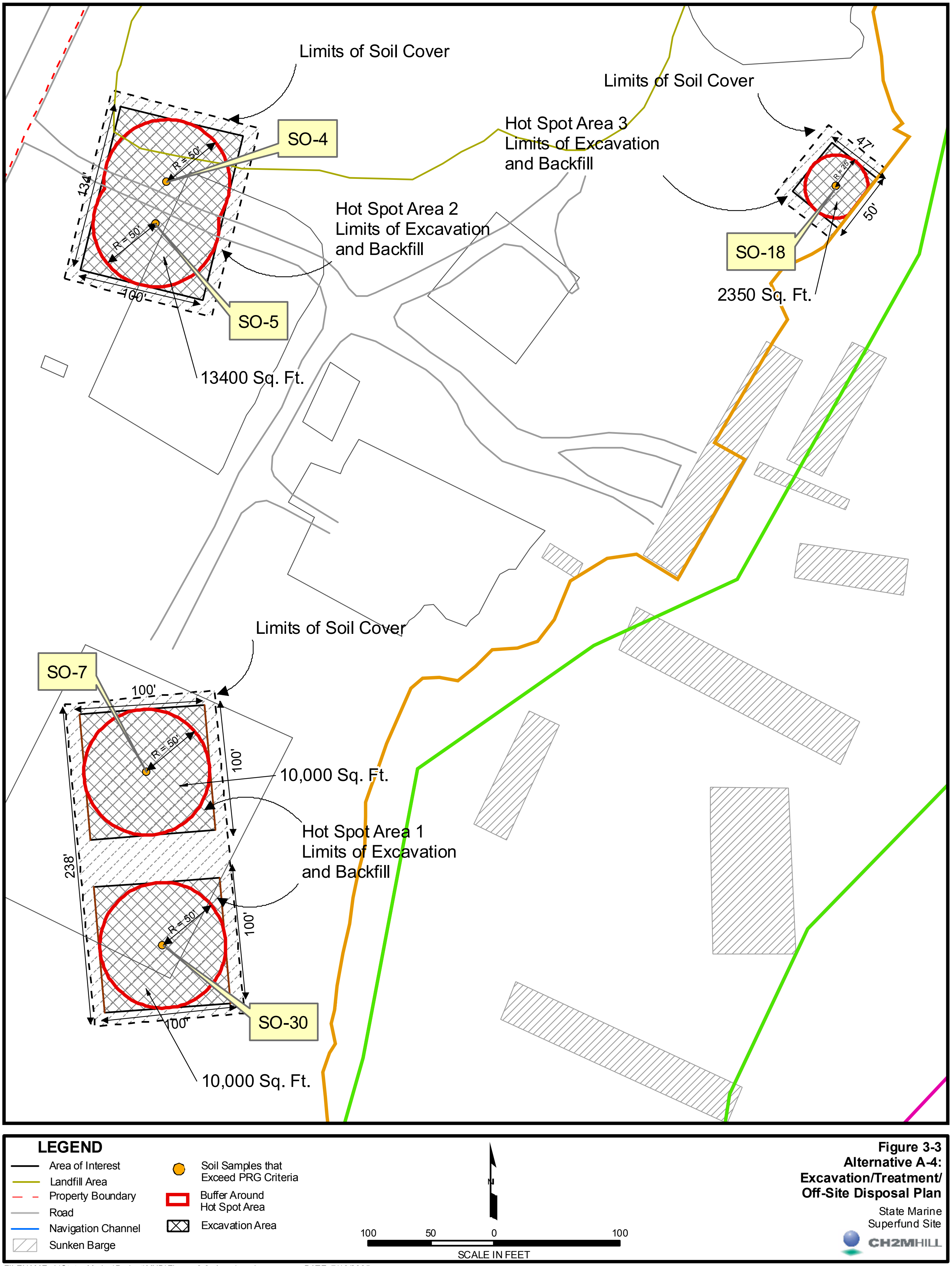


Figure 3-3
Alternative A-4:
Excavation/Treatment/
Off-Site Disposal Plan

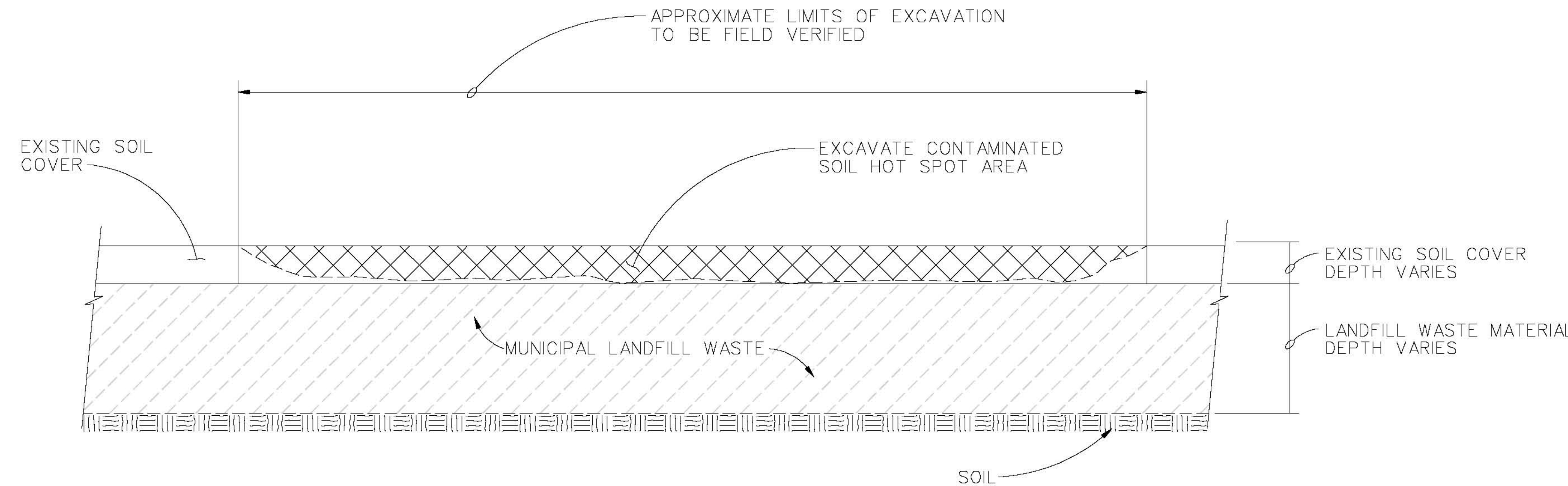
State Marine
Superfund Site

CH2MHILL

FILENAME: J:\State_Marine\Project\MXD\Figure_3-3_Area1.mxd DATE: 7/13/2005

005708

(This page intentionally left blank.)



SOIL HOT SPOT EXCAVATION
NTS

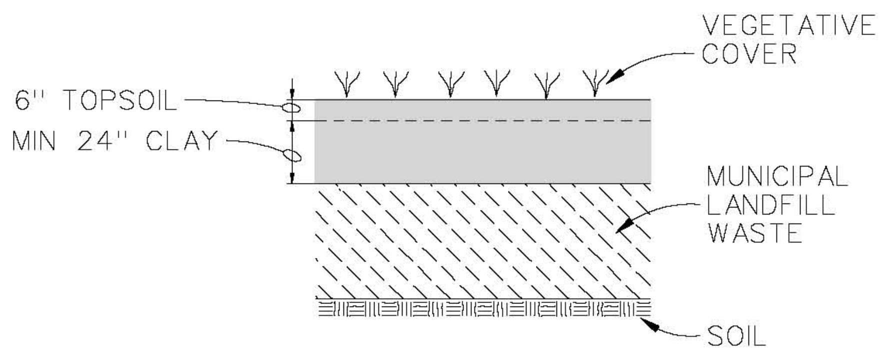
FIGURE 3-4
ALTERNATIVE A-4 : TYPICAL EXCAVATION SECTION
STATE MARINE SUPERFUND SITE
PORT ARTHUR TEXAS

CH2MHILL

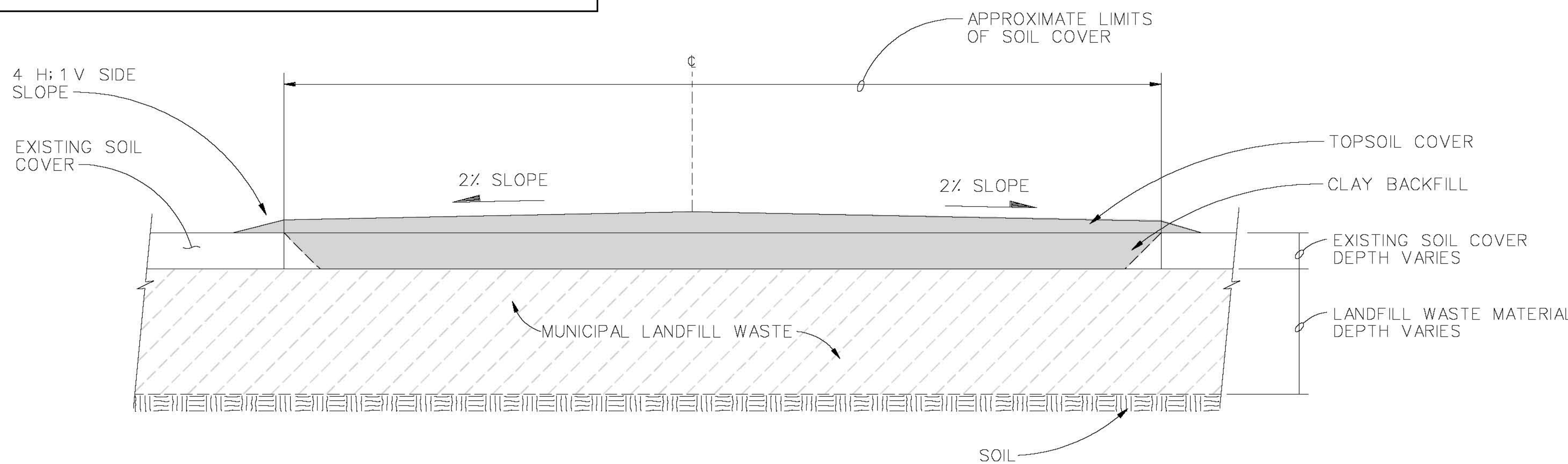
331756
state marine_cap section.dgn 13-JUL-2005 19:39:02

005710

(This page intentionally left blank.)



TYPICAL SOIL COVER DETAIL
NTS



BACKFILL AND COVER SECTION
NTS

FIGURE 3-5
ALTERNATIVE A-4 : TYPICAL BACKFILL AND COVER SECTION
STATE MARINE SUPERFUND SITE
PORT ARTHUR TEXAS

CH2MHILL

331756
state marine_cap section.dgn 13-JUL-2005 19:38:41

(This page intentionally left blank.)

Appendix A

Net Environmental Benefit Analysis

(This page intentionally left blank.)

Net Environmental Benefit Analysis

1.0 Introduction

This document presents the results of a Net Environmental Benefits Analysis (NEBA) conducted to support the selection of remedial alternatives for intertidal sediments at the State Marine Superfund Site. The purpose of the NEBA was to develop information that would enable the development of a defensible, scientifically-based cleanup approach for sediment. The overall goal was to identify potential remedial alternatives that would provide for the protection of the environment while providing the greatest net ecological value.

The NEBA process is consistent with the risk management objectives outlined in Superfund guidance. Within Step 8 of the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final* (EPA, 1997), the following two statements are made and NEBA provides a framework to meet this guidance:

- "The risk manager must balance (1) residual risks posed by site contaminants before and after implementation of the selected remedy with (2) the potential impacts of the selected remedy on the environment independent of contaminant effects."
- "In instances where substantial ecological impact will result from the remedy (e.g., dredging a wetland), the risk manager will need to consider ways to mitigate the impact of the remedy and compare mitigated impacts to the threats posed by the site contamination."

1.1 NEBA Overview

A NEBA—a process for comparing the benefits and costs associated with remedial action alternatives that affect the environment—was first used by EPA. The goal of a NEBA analysis is to rank these alternatives in terms of the total benefits realized from their implementation. A NEBA typically considers a broader range of environmental effects than the traditional RI/FS or RFI risk assessment process. These processes consider only the remedial alternatives' effects of limiting exposure from a contaminant release so the risks to human health and the environment are not unacceptable. The effects to other natural resource services (e.g., human use value, ecological service value) provided by the Site are typically not considered in the standard RI/FS or RFI risk assessment process. A NEBA evaluates both the positive and negative effects on natural resource services associated with a remedial action, as well as the potential incremental change in risk associated with each alternative. By considering the effects on all natural resource services provided by the Site, the net effects of remedial alternatives on all natural resource service flows are considered, including any potential loss of services being provided. For some cases, the remedial action may destroy or significantly degrade the ecological landscape, while achieving little or no reduction in ecological or human health risk. In some cases, the remediation may not result in a better quality habitat.

A NEBA is a credible method to quantify, compare, and demonstrate that one remedy may be better for an ecosystem than another. NEBA and Habitat Equivalency Analysis (HEA), a natural resource economic model commonly used in a NEBA, have been successfully applied to support natural resource damage assessments (NRDAs), to evaluate remedial alternatives under the Comprehensive Environmental Response, Recovery and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA), and to make decisions regarding permitting under the Clean Water Act (CWA).

The key tenets of NEBA are:

1) affected habitats provide natural resource services and have value;

2) remediation may not necessarily increase the level of natural resource services; and

3) habitats can be destroyed as a result of remediation, causing natural resource injury.

The NEBA conducted herein considers natural resource values (i.e., ecological values), risk profiles, and costs to provide a framework from which the EPA can reach a non-arbitrary, defensible basis for decisions regarding site cleanup.

1.2 Risks of Remedy

Active remediation of contaminated sediments affects the ecological communities associated with those sediments. It is often the case that healthy, active ecological communities are present in the contaminated areas, in spite of the contamination. In some cases, remediation may therefore reduce the net ecological service quality of the habitat remediated. For example, a sediment removal remedy also removes vegetation that produces oxygen; provides food and cover for wildlife; provides habitat for insects, reptiles, and amphibians; filters particles from the water; and reduces re-suspension of sediments. The risks associated with sediment remediation include these immediate effects, which can be extended due to the recovery time frame of the habitat impacted.

The risks of remedy are rarely formally quantified in common practice. *Instead, the assumption is commonly made that the risks associated with not performing the remedy far outweigh the risks associated with a remedy*. This approach is inconsistent with regulations and the recommendations of the scientific community, as shown in the following examples:

- "Selection of the appropriate remedial option at a contaminated sediment site will be undertaken on a case-by-case basis after careful consideration of the risks posed by the contaminants to human health and the environment, the benefits of remediation, the short- and long-term effects of implementing the remedial option, the implementability of the remedial option, and the costs of remediation." (Contaminated Sediment Management Strategy [CSMS]; page 7).
- According to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S. Code (USC) § 9621(b)(1)(G), the U.S. Environmental Protection Agency (EPA) must consider "the potential threat to human health and the

environment associated with excavation, transportation, and redisposal, or containment."

- According to 40 Code of Federal Regulations (CFR) §300.430(e)(9)(iii)(E)(1)-(3), "consideration of risks and impacts of remedy implementation to local communities, workers, and the environment is required."
- The Federal Register (FR) states that EPA must consider the "effects on human health and the environment during implementation of the remedial action" (55 FR 8,666, at 8,721 – March 8, 1990).
- The U.S. National Research Council (NRC) report, *A Risk-Management Strategy for PCB-Contaminated Sediments* (NRC, 2001), emphasizes the need to consider all risks at a contaminated site, not just human health and ecological effects, but also the social, cultural, and economic impacts. "The evaluation of sediment management and remediation options should take into account all costs and potential changes in risks over time for the entire sequence of activities and technologies that constitute each management option. Removal of contaminated materials can adversely impact existing ecosystems and can remobilize contaminants, resulting in additional risks to humans and the environment. Thus, management decisions at a contaminated site should be based on the relative risks of each alternative management action."

1.3 Value of Conducting a NEBA

While several documents produced by the EPA guide the performance of risk assessments for contaminated sediments, they do not focus on the risks associated with remediation. NEBA presents a sensible strategic approach for the decision-making framework. The NEBA strategic approach, including HEA, is explained in **Attachment A**. Specific procedures are detailed for evaluation of each of the scientific issues that govern risk. One major advantage of the NEBA approach is that it provides a standardized basis for quantifying the ecological benefits to the public for each remedial alternative. Another advantage is that the NEBA demonstrates these benefits to the public in a manner that facilitates comparison of the alternatives and increases understanding of how factors, such as environmental stewardship and reductions in risk, are considered in the remedial selection process. NEBA provides regulatory agencies with a framework to explain the justification for selecting a certain alternative to the public.

1.4 NEBA Focus

The NEBA for the Site focused exclusively on the intertidal sediments. The NEBA focused on the top one foot of sediments where risks were determined for benthic invertebrates from lead, which is the main COC. The NEBA was not considered for soils, where leaving human health risks in place was not an option and, thus, NEBA would not be a useful tool for screening remedial alternatives for those areas.

2.0 Study Area and Habitat Description

The following site description was presented in the RI for the Site:

Commercial and recreational fishing occurs year round at Sabine Lake. The total average commercial production is approximately 660,000 pounds per year (EPA, 2000b). Fish species inhabiting Sabine Lake include southern flounder (Paralichthys lethostigma), black drum (Pogonias cromis), red drum (Sciaenops ocellatus), spotted seatrout (Cynoscion nebulosus), northern red snapper (Lutjanus campechanus), and the greater amberjack (Seriola dumerilli) (Texas and Louisiana Saltwater Fishing Guides, 2002). The estuarine environment also supports a variety of crustaceans including brown shrimp (Penaeus aztecus), white shrimp (Penaeus setiferus), pink shrimp (Penaeus duorarum), and American commercial oyster (Crassostrea virginica) [TPWD, 2002]. Some marine mammals migrate or reside in Sabine Lake including the Atlantic bottlenose dolphin (Tursiops truncatus) and the manatee (Trichechus manatus) [EPA, 2000b]. River otters (Lutra canadensis) also inhabit the marshy areas of the Gulf region in Texas (Davis and Schmidly, 1994).

The marshy estuarine regions in Lake Sabine support a variety of amphibians and reptiles including the state and federally threatened green turtle (Chelondia mydas); the state and federally threatened loggerhead sea turtle (Caretta caretta); and the state and federally endangered Ridley sea turtle (Lepidochelys kempii) (TPWD, 2001). Other amphibians and reptiles that inhabit the region include the alligator snapping turtle (Macroclemys temminckii), southern dusky salamander (Desmognathus auriculatus), eastern newt (Notphthalmus viridescens), bronze frog (Rana clamitans clamitans), mud snake (Farancia abacura), and the Gulf crayfish snake (Regina rigida sinicola) (Texas Memorial Museum, 2002).

The SMS Site shoreline has been heavily modified by construction of a bulkhead that forms the outer edge of a pier that runs along most of the property boundary. A small portion of the southeastern shoreline retains some natural features. The SMS Site shoreline varies; some natural shoreline exists in the northern and southern portions of the property. The nearshore central area is heavily modified by the presence of piers, slips, marine salvage debris, and several sunken barges (WESTON, 2001a).

The intertidal area represents exposed sediments from the top of the bank along the shoreline to approximately the mean lower low water mark. The nearshore area is irregular in shape and encompasses both shallow sediments and those close to potential upland or on-site sources. The offshore area is a rectangular area of about 150 to 200 ft wide paralleling the navigation channel and representing the area most heavily influenced by ship traffic (WESTON, 2001a). The intertidal zone at the SMS Site supports a variety of macroinvertebrates that thrive on the sandy shores of the brackish water of Lake Sabine. These animals include American oyster (Crassostrea virginica), macoma clam (Macoma nasuta), blue crab (Callinectes sapidus), brown shrimp (Penaeus aztecus), white shrimp (Penaeus setiferus), and pink shrimp (Penaeus duorarum) (TPWD, 2002). Shorebirds found in shallow water along Sabine Lake are numerous including sandpiper species, terns, gulls, herons, egrets, and many others.

3.0 Evaluation of Sediment Risks

It is important to recognize that the purpose of any remediation undertaken for sediments at the Site is to prevent injury to ecological resources associated with contamination. It is also important to recognize that in many cases, stakeholders typically make remedial decisions based upon the "potential" for an injury to occur from a contaminant, not knowledge that an injury is in fact occurring or will occur in the future. Therefore, prior to discussing the BERA findings of sediment related ecological risks in sediments, it is important to understand the difference between risk and injury. These topics are discussed in the following section.

3.1 Importance of Differentiating "Risk" Versus "Injury"

The meaning of an "injury" to a natural resource is very different from a "risk" to a natural resource. This distinction is important when it comes to understanding those effects that have been documented (quantified/measured) through actual field studies versus those effects that "may have" or "potentially have" occurred, or those effects that "may" or "potentially" be occurring now and/or into the future. The differentiation between risk and injury has been made prominent based upon the NRDA regulations in the Oil Pollution Act where the public is to be compensated for natural resource injury that has occurred as a result of a release. Under NRDA, the lost natural resource services (injury) are quantified so that an appropriately scaled restoration program can be developed (service-to-service approach). In this approach, injury is measured (with some level of certainty) and used to develop the scale of the restoration program. Thus, there is some certainty that the restoration is adequate. "Potential" injury has a level of uncertainty around it (it may be there or it may not be there). The importance of this differentiation is that in the RI Report, the interpretation of the data leads to a discussion regarding "the potential for impact," which can lead to uncertain conclusions and conjecture regarding injury and harm. Risk and injury are discussed further in the following two sections.

3.1.1 Risk to Natural Resources

In the 1998 EPA Guidelines for Ecological Risk Assessment (an expansion and replacement for the 1992 ERA guidelines), risk assessment is defined as "*...a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors*" (e.g., exposure to a contaminant). "Risks" result from the existence of a hazard and uncertainty about its expression. Uncertainty is defined (Suter, 1993) as "*Imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal pattern of expression*." Since a "risk" evaluation typically looks at the "likelihood" of an adverse effect, it thus includes an implied level of uncertainty in the risk. Thus, simply put, a "risk" represents the "potential" that an injury may occur (with some level of uncertainty), not a measurable or observable injury.

3.1.2 Natural Resource Injury

"Injury" is defined in NOAA (1996) as follows*: "...an observable (i.e., qualitative) or measurable (i.e., quantitative) adverse change in a natural resource or impairment of a natural resource service."* This rule further defines natural resource services as *"...all functions that a natural resource provides for another natural resource(s) or for the public."* Natural resource services are classified as either ecological services or public services. In the case of a contaminant release, the natural resource trustees, under the NRDA rule, must determine that an "injury" to a natural resource has occurred. This "injury," whether to an ecological or public resource/service, is then quantified and used to develop a compensable restoration program. The compensable restoration program is thus scaled to the level of "injury" so that the level of the restoration program is appropriate. Compensatory restoration is not intended to include compensation for "risk" or "potential" injury or "potential" service losses, only measured and/or observed losses.

This distinction between "risk" and "injury" is important when it comes to evaluating claims as to the "potential" environmental harm associated with releases, in that when statements are made regarding the "potential" environmental harm (e.g., potential for impacts referred to in the RI/BRA Report), an implied level of uncertainty exists. Thus, implying injury when that injury is not measurable or observable leads to a level of uncertainty and consequently, uncertain conclusions.

3.1.3 Uncertainty

In the scientific community, bridging the gap between risk and injury is a complex issue. In Stahl and Barnthouse (2002), as an example, they discuss the misapplication of threshold or criteria values in evaluating potential ecological harm. As they indicate, in and of itself, comparison of concentrations to published criteria or literature is not sufficient to demonstrate injury or cause, nor is it "proof" of injury or harm. As the authors note, elevated chemical concentrations are not, by themselves, reliable indicators of adverse natural resource effects. For example, it is not uncommon for biological assessments of sediments (in the form of sediment toxicity tests) to be inconsistent with analytical chemistry results (i.e., high concentrations of hazardous substances present in the sediments yet the sediment sample is not toxic in a sediment toxicity test or compared to population community measured parameters). Thus, one cannot categorically presume that elevated levels of a particular hazardous substance equate to injuries or service losses.

The point is, a remedial decision based on a "potential" for an injury to occur should consider more than just chemical concentrations, such as the level of uncertainty associated with the identified risk as well as the potential ecological impacts associated with remedial alternatives in light of those uncertainties. The NEBA approach used herein examines these issues.

A discussion of the RI/HHRA/BERA findings follows.

3.2 Risks Associated with Sediments

The HHRA determined that there is no risk to adult fishers consuming fish from Sabine Lake.

In the BERA, risk was determined for benthic invertebrates due to elevated levels of lead in the intertidal area sediments. Toxicity is indicated by measured lead concentrations in sediment exceeding screening values and simultaneously extracted lead concentrations exceeding acid volatile sulfide concentrations (RI Report Appendix D). However, calculated risk to the benthic invertebrate community in the intertidal area is uncertain. The principles of AVS/SEM analysis are not readily accepted in the scientific community as detractors question whether the principle of the sulfide binding metals rendering them unavailable for uptake by benthic organisms is realistic. Additionally, the risks have not been supported by site-specific toxicity testing or community structure analysis. One of the most accepted practices for evaluating potential risk in sediment is the sediment quality triad that includes analysis of measured concentrations relative to screening values, the results of site-specific toxicity testing, and community surveys. With this method, two or more legs of the triad indicating the same result with respect to potential toxicity typically provide a basis for determining whether toxicity is likely occurring at a given site. Data is only available for one leg of the triad for the Site, thus results are not completely supported.

A discussion of derived cleanup levels presented in the FS is presented in the following section.

3.2.3 Results of Ecological PRGs

A site-specific preliminary remediation goal (PRG) was generated for lead. This PRG for benthic macroinvertebrates in surface sediments is 132 mg/kg. The results of the analysis for benthic macroinvertebrates, based upon a weight-of-evidence, indicate that there is a high degree of uncertainty associated with the selection of the PRG based on bulk sediment concentrations. The FS indicates that cleanup to existing PRG would be required in 0.4 acres of intertidal habitat. Based upon results of the BERA and the uncertainty associated with those results, remedial alternative involving removal were developed and evaluated as part of the NEBA.

3.3 Summary of Risk Evaluation

Based upon the uncertainties in the data set, the data do not support a conclusive statement of risk to macroinvertebrates associated with exposure to lead in surface sediments. If risk is present, it appears to be marginal at best. That is, although a slight risk may be identified in the BERA, there is a substantial amount of uncertainty and conflicting information that indicates that the potential for an ecological injury to occur may not be present. Given this, the decision to remediate sediments should consider other ecological aspects of the habitat that may be influenced by the remedial action. In addition, given the amount and level of uncertainty associated with the behavior and bioavailability of lead in the intertidal area, the PRGs for benthic invertebrates are also uncertain.

The NEBA was used to consider the potential influence that prospective remedial alternatives will have on the environment. The NEBA allows for the consideration, as stated earlier, that:

1) The affected habitats provide natural resource services and have value;
2) The remediation may not necessarily increase the level of natural resource services; and

3) That habitats can be impacted as a result of remediation, resulting in a loss of ecological services causing natural resource injury.

The remedial alternatives evaluated in the NEBA are discussed in the following section.

3.4 Remedial Alternatives Selection

In order to execute the NEBA, remedial alternatives were selected. These options were developed in the FS. Chapter 3 of the FS Report presents detailed discussion of the screening of alternatives. After initial screening, three main options remained: no action, removal with ex-situ treatment, and monitored natural attenuation. The NEBA included evaluation of seven alternatives that included variations of these three main options.

4.0 Net Environmental Benefit Analysis of Potential Remedial Alternatives

Three options were considered for the NEBA. The HEA methodology (**Attachment A**) was used to estimate the gains and/or losses associated with selected remedial options. All remedial options addressed risk in a total of 0.4 acres of habitat with sediment concentrations exceeding the lead PRG developed in the BERA.

The losses and/or gains in ecological service flows associated with management actions must be measured from a baseline condition. For all remedial options, it was assumed that the sediments in the intertidal area provide equal services among three main ecological groups—fish, shore birds, and the benthic community—with baseline services of 33 percent for all three areas. Net gains or losses were calculated in discounted service acre years (dSAYs) using the HEA method as differences from baseline conditions.

A common element of all the remedial options considered was that these options would only be considered if the results of the design investigation indicate the need for action. In the design investigation, data will be collected to reassess ecological risks calculated for the intertidal area. If the reassessment suggests there is no risk, then none of these options will need to be implemented. Each option was also evaluated in terms of whether it addressed the risks identified in the BERA. PRGs were developed for lead and areas of exceedance were calculated as presented in **Figures 2-3, 2-7, and 2-8** of the FS Report. A detailed description of each option, the assumptions made in calculating recovery curves, and final output of the HEA modeling and the NEBA are included below.

Option 1 – Removal of Lead PRG Exceedance Area

Under Option 1, it was assumed that the 0.4 acres of sediment exceeding the lead PRGs would be removed. A five-year linear recovery period was assumed for the benthic community to return to the baseline condition. It was also assumed there would be 100 percent loss of services associated with this option, as the value of the habitat to fish and wildlife would also be impacted. Recovery of the benthic community can occur on a non-linear basis as shown in **Exhibit 1**. It is assumed that the services of the other communities, fish and wildlife, would recover proportionally with the benthic community recovery. Assuming a five-year front weighted non-linear recovery in the HEA model would result in a net loss of ecological services of 0.49 DSAYs. However, associated with the removal of some sediments is great uncertainty associated with potential resuspension of contaminated sediments. For this reason, a second HEA model was run assuming that the five-year recovery was linear to account for the delayed recovery of the benthic community and associated ecological services that could result from disturbance and resuspension of contaminated sediments that is associated with sediment dredging operations. This second recovery is shown in **Exhibit 2**. The linear recovery would result in a net loss of ecological services of 0.97 DSAYs. These two models present a range of potential loss of services and it should be assumed that the actual loss of services might fall somewhere in between.

Exhibit 1. Non-linear Recovery of Ecological Services Associated With Sediment Removal

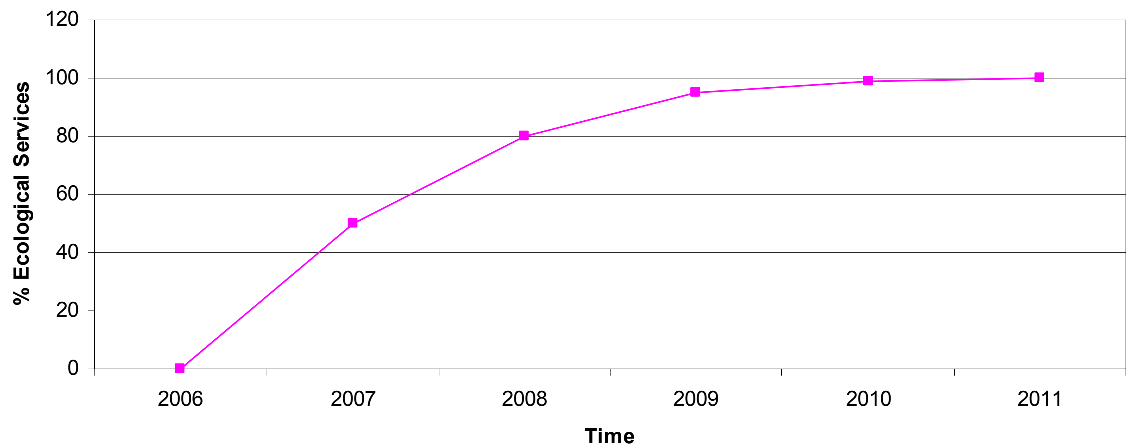
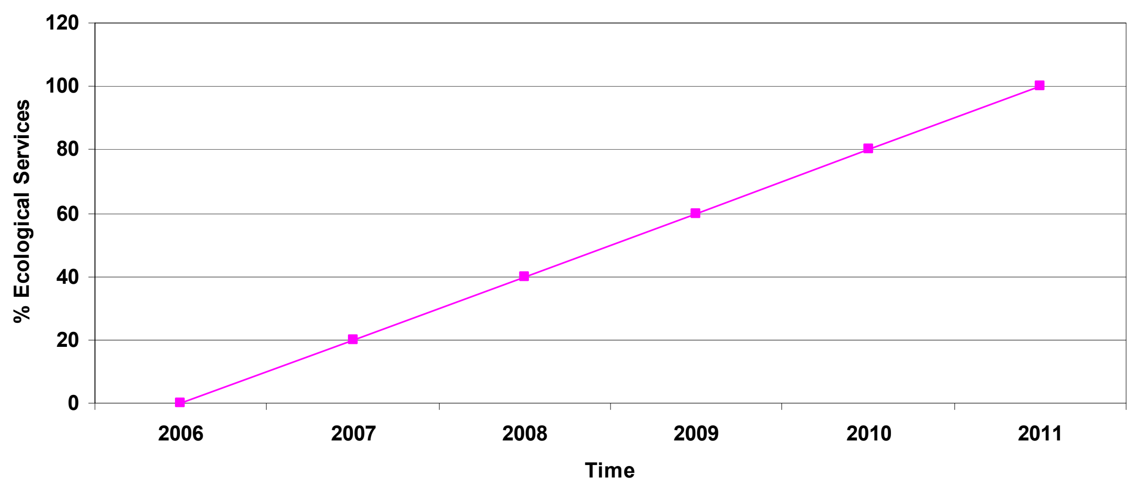


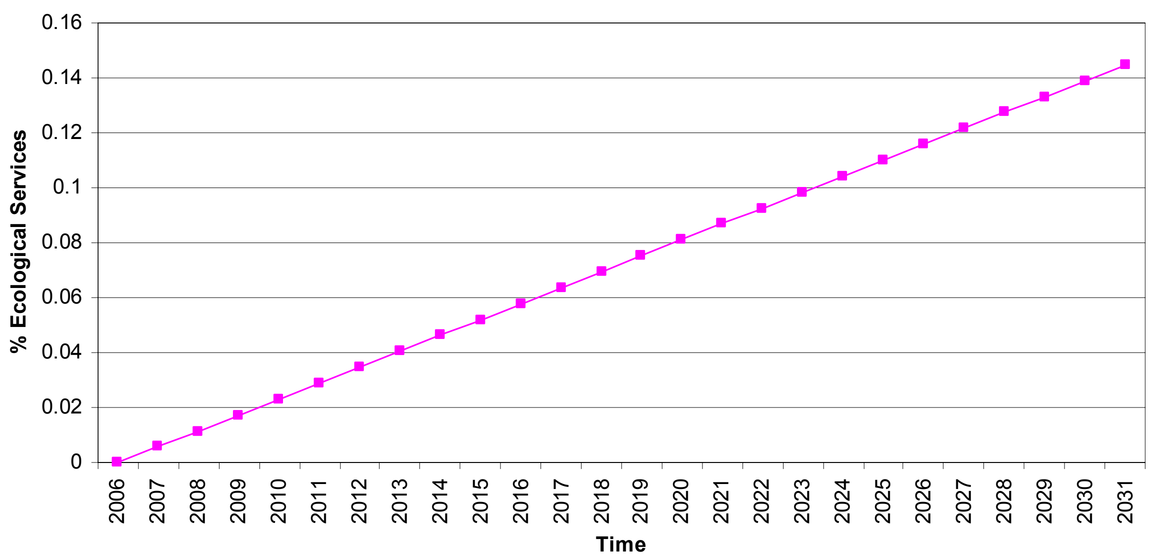
Exhibit 2. Linear Recovery of Ecological Services Associated With Sediment Removal



Option 2 – Monitored Natural Attenuation

Natural attenuation could be occurring in the intertidal area. Since the risks in place are thought to be low level risks with a high level of associated uncertainty, an option that included natural attenuation was considered. This option calls for five years of monitoring to develop an Action Memorandum. The Action Memorandum would include a summary of the analysis of monitoring data and then a recommendation to be implemented by EPA. The possible outcomes of the Action Memorandum are likely to include the following options: no further action, decreased frequency of monitoring, increased monitoring, or removal of waste. It was assumed in the HEA model that there are no active sources of lead continuing to contribute add to existing concentrations and that natural attenuation would return concentrations to acceptable levels (below PRGs) within 25 years. The recovery curve is shown in **Exhibit 3**.

Exhibit 3. Linear Recovery of Ecological Services Associated with MNA



Unlike with the sediment removal option, this option does not account for 100 percent loss of services. Existing lead concentrations in relation to screening values were used to estimate the percent loss of services. It was assumed that concentrations above the ERL are a 10 percent loss of services, concentrations above the ERM are a 50 percent loss, and those in between are a 35 percent loss. Since the three hot spot areas being removed are fairly close in size, the percent loss of services from all three was averaged. With two hot spots above the ERM and one between the ERL and ERM, the average is a 43 percent loss of services. The average percent loss of services was then multiplied by the baseline level of services to determine the final or overall percent loss of services of 14.3 percent. The HEA model assumes service loss associated with the presence of lead would decrease linearly for the 25 years of recovery. Thus, Option 2 represents a net loss of services of 0.58 DSAYs.

Option 3 – No Action

For the purposes of determining the net loss or gain of ecological services, there is essentially no difference between the no-action and monitored natural attenuation Option 5. The net loss is 0.58 DSAYs. However, this option is still considered because, in the final selection of the preferred alternative, the amount of risk left in place and the overall cost over a five-year period was also considered as decision criteria in selecting the final remedy. Unlike monitored natural attenuation, there is no cost associated with no action; thus, it represents a distinct remedial option.

Summary

A summary of the NEBA results is provided in Table 1.

TABLE 1. NEBA SUMMARY TABLE

Remedial Option Number	Description of Remedial Option	A DSAYs	B Residual Risk	C Cost over five years
1	Sediment Removal	**-0.49 t0 -0.97**	None	$1,524,000
2	MNA	**-0.58**	Low lead risk	$286.000
3	No Action	**-0.58**	Low lead risk	$0

Column A: Represents the net ecological service value associated with implementation of the alternative, as calculated using Habitat equivalency analysis (HEA).
Column B: Represents the "risk" remaining after implementation of the alternative. E.g., may go from "low" risk to "negligible" risk to "no" risk.
Column C: Represents the cost associated with implementing the alternative.

A NEBA was conducted to compare potential remedial alternatives for consideration in the FS development. The available data indicate the potential for marginal ecological risks associated with the intertidal area. Given that the risks are marginal, we considered the impact of each remedial alternative on ecological services. Within the NEBA, assumptions were made regarding various input parameters and as such, this analysis is exploratory in nature. The key stakeholders would be expected to work collaboratively to further refine the analyses in order to suit those purposes based on the best information available at that time.

The results of the NEBA presented above in **Table 1** suggest that Option 3 - Monitored Natural Attenuation is the best remedial option for the intertidal area at this time. The NEBA considered not only the net impact to the environment, but also the amount of residual risk left in place and the cost of the remedial option.

As can be seen in **Table** 1 above, it is evident that Options that include the removal of the existing contamination result in a similar to slightly greater net loss of ecological services compared with those left in place. However, the costs associated with the removal actions are significantly higher to remove risks that are uncertain. Thus, Option 1 could be eliminated because in addition to having a greater net loss of ecological services, it also represents a more costly option compared to Options 2 and 3. Option 2 represents a better solution than option 3 because there is currently insufficient data to determine if the natural attenuation will be successful and if active sources of contamination still exist.

5. Works Cited

Brown, M. 1999. *The Role of Natural Attenuation/Recovery Processes* In Managing Contaminated Sediments. Sediment Management Workshop, Detroit, MI. http://www.smwg.org/products/techpapers/paper2.pdf

Efroymson, R.A.; J. P. Nicolette; and G. W. Suter. 2003. *II A Framework for Net Environmental Benefit Analysis for Remediation or Restoration of Petroleum-Contaminated Sites*. January.

Federal Remediation Technologies Roundtable (FRTR). 2002. *Remediation Technologies Screening Matrix and Reference Guide, Fourth Edition*. January.

Iadanza, N. 2001. *Appendix C, Determining Habitat Value and Their Time to Sustained Function*. National Oceanic and Atmospheric Administration. In Damage Assessment and Restoration Program Northwest Region Commencement Bay Hylebos Waterway Natural Resource Damage Settlement Proposal Report (http://www.darcnw.noaa.gov/cbhy-c.pdf)

MacDonald, D. D. 1994. *Sediment Injury in the Southern California Bight: Review of the Toxic Effects of DDTs and PCBs in Sediments*. Prepared for NOAA, August 1994, by MacDonald Environmental Sciences Ltd. Ladysmith, B.C., V0R 2E0. 96 pp. + Appendices.

National Remedy Review Board. 1998. *Pine River Environmental Project Description of Remedial Alternatives*. National Remedy Selection Briefing. http://pineriver.alma.edu/documents/legal/030298/section2.htm

National Research Council (NRC). 2001. *A Risk-Management Strategy for PCB-Contaminated Sediments*. National Academy Press, Washington, D.C.U.S.

Naval Facilities Engineering Command (NAVFAC). 2002. *TDS-2092-ENV Contaminated Sediments at Navy Facilities: Cleanup Alternatives*. December.

U.S. Army Corps of Engineers (USACE). 2001. Regulatory Guidance Letter, October 31, 2001. RGL 01-1. http://www.usace.army.mil/inet/functions/cw/hot_topics/rgl01_1.pdf

US Army Corps of Engineers (USACE). 2002. Regulatory Guidance Letter, December 24, 2002. RGL 02-2. http://www.usace.army.mil/inet/functions/cw/hot_topics/rgl02_2.pdf

U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE). 1992. *Evaluating Environmental Effects of Dredged Material Management Alternatives - A Technical Framework (EPA842-B-92-008) October 1988*; OSWER Directive Number 9355.3-01)

U.S. Environmental Protection Agency (EPA). 1993. *Assessment and Remediation of Contaminated Sediments (ARCS) Program: Risk Assessment and Modeling Overview Document*.

U.S. Environmental Protection Agency (EPA). 1998. *EPA's Contaminated Sediment Management Strategy*. EPA-823-R-98-001.S. EPA.8U.S.

U.S. Environmental Protection Agency (EPA). 1997. *Overcoming Obstacles to Sediment Remediation in the Great Lakes Basin*. EPA-905-R-93-007. International Joint Commission. November 19.

U.S. Environmental Protection Agency (EPA). 1993. *Selecting Remediation Techniques for Contaminated Sediment EPA-823-B93-001*. June.

Van Metre, P.C., J.T. Wilson, E. Callender, and C.C. Fuller. 1998. Similar rates of decrease of persistent, hydrophobic, and particle-reactive contaminants in riverine systems. Environmental Science and Technology 32: 3312-3317.

Wolotira, R. 2002. Appendix D: Defining Injuries to Natural Resources in Hylebos Waterway. National Oceanic and Atmospheric Administration. In Damage Assessment and Restoration Program Northwest Region Commencement Bay Hylebos Waterway Natural Resource Damage Settlement Proposal Report (http://www.darcnw.noaa.gov/cbhy-d.pdf)

(This page intentionally left blank.)

Attachment A

Net Environmental Benefits Analysis (NEBA) Overview

A NEBA is an approach for addressing risks associated with site contamination that are considered to be marginal or otherwise manageable. For example, in the remedial process responsible parties spend a minor amount (e.g., 10 percent) of their remedial costs in removing or managing 90 percent of the contamination/risk present. Thus, they spend the majority (e.g., 90 percent) of their costs removing or addressing the remaining 10 percent of risk/contamination associated with a site (e.g., trying to reach a certain criteria). The risks associated with some fraction of the remaining contamination are, in many cases, a marginal or an otherwise manageable risk. In some cases, increased remedial costs may not change the overall risk scenario. Furthermore, remedial actions undertaken to further reduce or eliminate these risks can cause substantive ecological losses. Such remedial actions provide little risk reduction benefit and thus, provide little or no value to the public at unnecessarily high cost, both in terms of dollars and lost services of the environment. A NEBA approach can be used to evaluate alternative remedial strategies to determine which of those strategies will provide the greatest net environmental benefit to the public.

In the example mentioned above, a NEBA approach provides a strategy to address the question: "How can we address the marginal or otherwise manageable risks associated with the site contamination?" A key goal of a NEBA approach is to minimize costly remedial efforts that may provide little value to the public from a risk management and environmental perspective (i.e., can ERP provide the public with a greater net environmental benefit through a less intrusive and less costly alternative management/ remedial strategy?).

Technical Justification for a NEBA

Introduction

NEBA is an approach that uses different techniques for comparing the benefits of remedial alternative actions that affect the environment. The goal of the analysis is to rank these alternatives in terms of the total environmental benefits realized from the implementation of those actions.

NEBA has its theoretical foundations in welfare economics, as do benefit-cost analysis, risk-benefit analysis and cost-effectiveness analysis. Each analysis framework comes with tools and measurement methods that have their advantages and disadvantages, depending upon the decision they are intended to support and the nature of the effects they are attempting to measure. For example, the preferred metric in a benefit-cost analysis is usually dollars in order to facilitate aggregating across a wide range of effects from alternative policy actions. However, in the case of assessing morbidity or mortality benefits, other metrics, such as reduced cancer risk or statistical lives saved, are often preferred.

To assess ecological benefits, NEBA frequently uses environmental metrics based on the flows of ecosystem services.[1] Such metrics are preferred over monetary metrics to capture ecological service flows that provide indirect human use benefits. Such basic ecosystem support services are relatively difficult to quantify in dollar terms and yet can be significantly impacted by remedial alternatives. Direct human use benefits from natural resources and the environment, such as recreational fishing and hunting, wildlife observation, nature photography, etc., are generally quantified in dollar terms using economic valuation tools that rely upon observations or verbal statements about recreation behavior. Thus, depending upon the problem and the nature of the available data, different metrics may be used to measure and compare the potential benefits from alternative actions.

By considering the effects on all ecological services provided by the site, the net effects of remedial alternatives on all ecological service flows are considered, including any potential loss of services being provided. For some cases, the remedial action may destroy or significantly degrade the ecological landscape, while achieving little or no reduction in ecological or human health risk. NEBA can evaluate whether the "cure is worse than the disease."

NEBA also allows the consideration of any actions that may augment ecological services to compensate for any ecological losses. These actions usually are classified as restoration actions, although they may encompass other actions, such as changes in a manufacturing process, changes in seasonal water usage to maintain minimum flows for important species, site habitat conservation, etc. NEBA evaluates the overall package of remedial and restoration alternatives to assess their combined effect on the total ecological services provided by a site.

Relative to direct human use services of the environment, indirect human use services have received more consideration recently. This change is due to the relatively recent development of the HEA method, which primarily measures changes in ecological services. HEA was developed by the U.S. Fish and Wildlife Service (Unsworth and Bishop, 1993). It has been adopted by the National Oceanic and Atmospheric Administration (NOAA) and Department of Interior (DOI) as a method to scale compensatory restoration options in natural resource damage assessment (NRDA) under the Oil Pollution Act of 1990 (OPA) (NOAA 1997a; 1997b). Considering its relatively recent development, the HEA method is described briefly below.

[1] From the DOI (1997) regulations, ..."services include provision of habitat, food and other needs of biological resources, recreation, other products or services used by humans, flood control, ground water recharge, waste assimilation, and other such functions that may be provided by natural resources.

From the OPA (1996) regulations, "Services (or natural resource services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public." NOAA guidance further classifies natural resource services as:

Ecological services - the physical, chemical, or biological functions that one natural resource provides for another natural resource and thus indirectly provides value to the public. Examples include provision of food for wildlife, protection from predation, and nesting habitat, among others: and ,

Human services - the human uses of natural resources or functions of natural resources that provide direct value to the public. Examples include fishing, hunting, nature photography, and education, among others.

Habitat Equivalency Analysis (HEA)

Habitat Equivalency Analysis (HEA) is based on the identical conceptual framework as other economic valuation methods, but it measures ecological services only [2] (See Jones and Pease, 1997, for the technical details.) The purpose of any economic method used in NEBA is to evaluate a set of remedial actions, each of which will alter ecological service flows from a site. For any remedial action, a general equation for expressing in dollar terms the value of a change in ecological services at the site brought about by that action is:

$$\text{Value of implementing remedial action R} = \sum_t (1/1+r)^t \sum_s v_s \left(Q^R_s - Q^O_s \right),$$

Where r is the discount rate[3], v_s is the dollar value of the last unit provided of environmental service s, Q^O_s is the baseline level of environmental services, Q^R_s is the level of that service flow resulting from the remedial action R [and so ($Q^R_s - Q^O_s$) is the change in services)]. This equation implies that by valuing the changes in service flows over time at a constant incremental value vs these changes may be expressed in dollars and can be added up. The value of these changes is then adjusted by the discount rate so that summing up over all the periods provides the present discounted value of the change in services to the ecosystem from the remedial action.

If another remedial action, W, is considered, then a similar valuation may be performed, as well. The rule for NEBA and benefit-cost analysis is to compare these values and rank them, so that if the:

> Value of implementing remedial action R > Value of implementing remedial action W

Then R is preferred to W.

Now, assume that: 1) there is only one service flow that is affected and 2) the value of the service is constant through time. Then the fundamental equation becomes:

$$\text{Value of implementing remedial action R} = \sum_t (1/1+r)^t\, v \left(Q^R_s - Q^O_s\right)$$

and the v, because it is constant through time, can be taken outside of the summation and canceled. The imposition of these assumptions implies:

$$\text{HEA:} \quad \sum_t (1/1+r)^t \left(Q^R - Q^O\right)$$

---

2 This section relies heavily upon Tomasi, Theodore, Mary Jo Kealy and Mark Rockel "Scaling Compensatory Restoration Under the 1990 Oil Pollution Act" Paper ID #265 International Oil Spill Conference, Seattle, WA. 1999.

3 To understand the concept of discounting, compare it with a more familiar concept, the compounding of interest on savings. Compounding takes an amount invested today and determines what it will be worth at some future date. Specifically, at six percent interest, $100 invested today will earn $6.00 in interest and will be worth $106 a year from now. In year two, the investment will earn interest of $6.36 on the $106 for a total investment value of $112.36. In twelve years the value of the investment will have doubled to $200 and it will have doubled again to $400 in twenty-four years.
Discounting works in the reverse direction. It begins with an amount that will be received at some future date, say $200 twelve years from now, and computes what it is worth today. Discounting at six percent a year gives a present worth of $100. The larger the discount rate, the lower is the present worth. For example, a ten percent discount rate applied to a $200 value twelve years from now, would be worth about $64 today.
The Trustees have used a discount rate of 3 percent. Under the DOI regulations a 3 percent real discount rate is mandated. Comments for the proposed regulations during the public comment period indicated that most professional economists agreed upon using a range of 2-4 percent for the real discount rate.

HEA attempts to accomplish what any other economic method purports to accomplish. Namely, it determines the present discounted value of changes in ecological services over time from remedial action R and compares that value to the present discounted value of ecological services provided by remedial action W over time. By assuming that v is constant over time and therefore drops out, HEA simplifies the focus to determining ecological service flow losses and gains from the biological and ecological perspective only. That is, HEA values the changes in ecological services from a remedial action without using economic values because any values of ecological service gains and losses for all remedial actions considered are constant by assumption. Because the pilot NEBA studies are comparing the effects of remedial alternatives on the same ecosystem, these assumptions appear to be reasonable.

HEA Equations

HEA is a set of equations designed to implement service-to-service scaling. In the HEA framework, the service flows from the natural resource is normalized using the value of the service flows over time from the injured natural resource at baseline conditions. The HEA representation of scaling of compensation in the absence of any uncertainty about future service flows is:

$$\left[\sum_{t=0}^{B} \rho_t \left(b^j - x_t^j\right)/b^j\right] * J = \left[\sum_{t=I}^{L} \rho_t \left(x_t^p - b^p\right)/b^j\right] * R$$

where t is time in years and the following notation applies :

t = 0, the injury occurs and the claim is presented

t = B, the injured habitat recovers to baseline

t = I, increment in services from restoration project begins

t = L, restoration project services terminate.

x_t^j, the level of services per acre provided by the injured habitat in year t

b^j, the baseline level of services per acre of the injured habitat

x_t^p, the level of services per acre provided by the restoration project in year t

b^p, the initial level of services per acre of the restoration project

ρ_t, discount factor where $\rho_t = 1/(1+r)^t$, and r is the discount rate

J, the number of injured acres

R, the size (in acres) of the restoration project.

(NOAA, 1997a)

When using HEA as a scaling tool, the analyst must specify the ecological service flows from the injured natural resource at baseline and in its injured state. The left-hand side of the HEA scaling equation is the present value of ecological service losses per acre (as percentage of baseline services) times the number of injured acres. The right-hand side is the present value of the increment to ecological service flows per acre from the restoration project (also expressed as a percentage of baseline services from the injured resource).[4] The equation would then be solved for R as the size of the restoration project in acres needed to compensate the public for the injuries.

For a NEBA, the change in environmental services from undertaking alternative remedial actions must be measured. Within HEA, this is done by developing indicators of the ecological service flows from the site and expressing the changes in services from the site under alternative remedial actions as percentage changes from a baseline or reference condition.

For a NEBA, the amount of habitat available at the site (usually expressed in acres) is measured. The major service flow from the site is identified, and some structural or functional indicators of the ability of the habitat to provide that service flow are then developed. A baseline or reference habitat is specified. This baseline habitat is defined to provide 100 percent of the service flows from a habitat. Using indicator(s) of service flows, the service flows under alternative actions are compared as a percentage difference relative to the baseline. Note that if the reference area is an ideal habitat, the flow of services from the habitats being evaluated are always less than or equal to 100 percent, but quality differences of an evaluated habitat relative to a reference habitat could generate more than 100 percent of services.

The units of comparison are called service acre years (SAYs). One acre of shrub-steppe habitat operating at 100 percent service flows generates, over a 1-year period, one SAY of services. Taking into account the acreage and the percentage differences in amount of services, the evaluated habitats provide a certain number of SAYs each year. For example, 20 acres of shrub-steppe habitat operating at 80 percent of reference services in a given year provide 16 SAYs in that year. Because benefits occur over time, an adjustment in those service flows needs to be made using a discount rate. This yields discounted service acre years (dSAYs).

To determine the dSAYs for each alternative remedial action, the following inputs are needed:

- Affected area (in acres)
- Percentage of services in each year relative to baseline
- Discount rate

The first two inputs are site-specific and rely on scientific information such as an understanding of the hydrogeology of the area, extent, and geomorphic characterization of the habitat, nature and extent of the contaminants, life requisites of the species, toxicological effects of the contaminants on the species, and how each remedial alternative will affect those variables. The third input is a general parameter.

---

4 The equation assumes constant services at baseline from both the injured and restored resource; this is not necessary in the analysis (NOAA, 1997a). Also, this is stated as a single service flow. The NOAA document states that this may be a weighted sum of multiple service flows, but does not state how such weights might be derived.

Selection of an Indicator to Represent Ecological Services

One critical assumption is that the total services generated by a habitat can be represented by a single indicator or several indicators that may then be aggregated into one. Obviously, the selection of an appropriate indicator has important implications.

There are several approaches to selecting an indicator. One approach is to assume that the ecosystem provides only one service. However, choosing the indicator that best measures that service can be problematic.

If the habitat provides multiple services that are considered important, then the choice of an indicator becomes more problematic. There are three general approaches to dealing with this issue. The first is to identify the multiple services being provided by the habitat and weight those services so that they may be aggregated into a single service. From a measurement perspective, indicators would be selected to measure each service flow and then aggregated using weights to form a single indicator. The implication is that weights must be developed.

A second approach for dealing with multiple services in HEA is to assume that all of the services move together in lock-step. Then, the services can be aggregated into a single service. As long as the services injured are the same as the ones augmented in compensation, it looks just like the single-service model. In essence, HEA uses a single indicator of all services and then assumes that all services move in equal proportion to the one indicator. The indicator effectively becomes the aggregate service. The percentage change in this aggregate service (for example, 50 percent) over time and space will determine the change in services.

A third approach for dealing with multiple service flows is to recognize that multiple services exist, but to choose one on which to focus. To be conservative this one is usually the "maximally affected" service. This service is assumed to have suffered the greatest ecological service loss and by focusing on it, all other ecological services provided by the habitat that have suffered losses are accounted for as well.

The selection of an indicator to represent ecological service losses is critically important to any HEA. The approach selected will ultimately depend upon the specific characteristics of the habitat being evaluated and the availability of information.

References

Bay Environmental Study Team and the Florida Department of Environmental Protection (FDEP). 1998. *Managing the Nearshore Waters of Northwest Florida: St. Andrew Bay, A Look to the Future, A Management Plan for the St. Andrew Bay Ecosystem*.

Chafin, L.G. 2000. *Field Guide to the Rare Plants of Florida*. Florida Natural Areas Inventory.

Earth Tech. 2001. *Draft Remedial Investigation and Baseline Risk Assessment Report for Site OT029, Tyndall Air Force Base, Florida*. Prepared for Tyndall Air Force Base Air Force Center for Environmental Excellence. Tyndall AFB, Florida.

Federal Remediation Technologies Roundtable (FRTR). 2002. Guidance Document: *Remediation Technologies Screening Matrix and Reference Guide, Fourth Edition*. January. http://www.frtr.gov.

Florida Natural Areas Inventory and the Florida Department of Natural Resources. 1990. *Guide to the Natural Communities of Florida*.

Hipes, D.; D.R. Jackson; K. NeSmith; D. Printiss; and K. Brandt. 2001. *Field Guide to the Rare Animals of Florida*. Florida Natural Areas Inventory.

Jones, C.A., and K.A. Pease. 1997. *Restoration-Based Measures of Compensation in Natural Resource Liability Statutes*, National Oceanic and Atmospheric Administration (NOAA) Damage Assessment Center. June.

Keppner, E.J. 1996. *An Inventory of the Biological Resources Reported from the St. Andrew Bay Estuarine System, Bay County, Florida*. Printed by the Bay Environmental Studies Team with the Assistance of the USFWS, Panama City field office.

Keppner, E.J., and L.A. Keppner. 1997. *A List of the Vascular Plants of Bay County, Florida*. Published by the Bay Environmental Study Team with the assistance of the Florida Department of Environmental Protection, Panama City branch office, and the USFWS, Panama City field office.

National Oceanic and Atmospheric Administration (NOAA). 1997a. Habitat Equivalency Analysis: An Overview, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program.

National Oceanic and Atmospheric Administration (NOAA). 1997b. Scaling Compensatory Restoration Actions. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program.

National Research Council (NRC). 2001. *A Risk-Management Strategy for PCB- Contaminated Sediments.* National Academy Press. Washington, D.C. (Available from National Academy Press http://www.nap.edu/bookstore)

Nelson, D.M. (editor). 1992. *Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries, Volume I: Data Summaries*. ELMR Rep. No. 10. NOAA/NOS Strategic Environmental Assessments Division.

Pattillo, M.E.; T.E. Czapla; D.M. Nelson; and M.E. Monaco. 1997. *Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries, Volume II: Species Life History Summaries*. ELMR Report No. 11. NOAA/NOS Strategic Environmental Assessments Division.

Rust Environmental and Infrastructure. 1998. *Draft Aquatic Ecological Risk Assessment, OT-29 Fred Bayou, Tyndall Air Force Base Installation Restoration Program*. Prepared for the Air Force Center for Environmental Excellence, Environmental Restoration Division, Brooks Air Force Base, Texas.

Tomasi, T.; Kealy, M.J.; and Rockel, M. 1999. *Scaling Compensatory Restoration Under the 1990 Oil Pollution Act*. Paper ID #265, International Oil Spill Conference, Seattle, Washington.

Unsworth, R.E. and R. Bishop. 1993. *Assessing Natural Resource Damages Using Environmental Annuities*, Ecological Economics, 11(1994) 35-41.

U.S. Environmental Protection Agency (EPA). 2000. *Guidelines for Preparing Economic Analyses.* EPA 240-R-00-003. September.

U.S. Fish and Wildlife Service (FWS). 1998. *Environmental Contaminant Evaluation of St. Andrew Bay, Florida. Volumes I and II*. Publication No. PCFO-EC 98-01.

U.S. Geological Survey (USGS). 1982. Quadrangle map of Long Point, Florida.

Appendix B

Cost Estimates for Remedial Alternatives

(This page intentionally left blank.)

TABLE B-1: Alternative A-2 - Institutional Controls +50%/-30% Cost Estimate
State Marine Site Focused Feasibility Study
Port Arthur, Texas

PRELIMINARY

ITEM	Description	BASELINE QTY	UNIT	UNIT COST	COST VALUE	BASELINE REMARKS
	CAPITAL COSTS					
Institutional Controls						
1	DEED RESTRICTIONS	1	LS	15,000.00	15,000	100 man hours @ $150
2	CLEAR/REMOVE BRUSH/TREES	2,000	LF	2.70	5,400	Clearing for installation of fence. 2,000 x 20 = .9 acre @ $6000/ Acre
3	FENCE (6' GALVANIZED CHAIN LINK)	2,000	LF	22.00	44,000	Install 25 ft outside of perimeter of each hot spot remediation area.
4	GATES (6' GALVANIZED CHAIN LINK)	3	EA	1,000.00	3,000	10' Wide Single Swing Gate. 1 gate for each hot spot area.
5	SIGNAGE	10	EA	150.00	1,500	Install signage on fencing (1 sign per 200 lf of fence)
Other						
6	HEALTH AND SAFETY	1	LS	4,000.00	4,000	Development and implementation of H&S Plan, Activity Hazard Analysis. 40 man hours @ $100/hr
7	SURVEYING	1	LS	1,000.00	1,000	(1) 10-hour day based on $100 per crew hour
8	SUPERVISION	180	HR	105.00	18,900	18 working days @ 10 hr/day, plus per diems, travel, and car expenses
9	CONSTRUCTION REPORT (AS-BUILT DRAWINGS)	1	LS	6,000.00	6,000	
10	CONSTRUCTION INDIRECTS	1	MO	5,000.00	5,000	
	Subtotal				**103,800**	
11	Contingency	20	%		20,760	
	Subtotal - Construction Costs				**124,560**	
12	General Requirements	12	%		14,947	
13	Permitting & Legal	1	%	18,000.00	18,000	120 man hours @ $150
14	Services During Construction	10	%		12,456	Including field engineering, engineering support, etc.
15	Project Management, Engineering and Design Cost	10	%		12,456	
	Subtotal - Implementation cost				**57,859**	
	Total - Capital Costs				**182,419**	
18	**Fee -**	12	%		**21,890**	
	Total - Proposed Sales Price				**$204,310**	
	ANNUAL O&M COSTS					
19	PROJECT MANAGEMENT (MONITORING & INSPECTION)	40	HR	150.00	6,000	
	Subtotal - O&M Costs				**6,000**	
	Contingency	20	%		1,200	
	Total - O&M Costs				**$7,200**	
	Real Discount Rate	3.1%				30 Year life, Real discount rate of 3.1% from App C of the OMB Circular No. A-94, revised January of 2005
	Net Present Value of 0+M				**$139,300**	
	Total Net Present Value				**$343,610**	

TABLE B-2: Alternative A-3 -Onsite Soil Cover +50%/-30% Cost Estimate

State Marine Site Focused Feasibility Study

Port Arthur, Texas

PRELIMINARY

ITEM	Description	BASELINE QTY	UNIT	UNIT COST	COST VALUE	BASELINE REMARKS
	CAPITAL COSTS					
Mobilization and Site Preparation and Temporary Facilities						
1	MOB-DEMOB	1.0	LS	20,000.00	20,000	
2	STAGING AREA	62.0	CY	25.00	1,550	Assumes 4" thick layer of gravel to be placed on staging area (50 ft x 100 ft)
3	PROTECT & MAINTAIN EXISTING UTILITIES	1.0	LS	1,000.00	1,000	Survey, pothole locate, and mark
4	IMPROVE SITE ACCESS ROADS (610 ROAD BASE)	162.0	CY	30.00	4,860	Place, grade and compact 6" of 610 road base to improve exst dirt site access roads (10 ft wide road x 875 LF)
5	SITE TRAILERS & UTILITIES	2.5	MO	1,500.00	3,750	Rental of site trailer, utility hookup and monthly fees
6	PORTABLE TOILETS	1.0	EA	300.00	300	Rental of portable toilet
7	CLEAR AND GRUB WORK AREA	2.0	AC	3,500.00	7,000	Remove trees and brush to 25 ft outside of the perimeter of each hot spot area and to limits of staging area
Stormwater Runoff Control and Treatment						
8	RUNOFF/EROSION CONTROL (SILT FENCE)	1900.0	LF	8.00	15,200	Install 25 ft outside of perimeter of each hot spot remediation area.
9	TEMP DECON FACILITY (CONST, MAINTAIN, OPERATE)	1.0	LS	15,000.00	15,000	Equipment decon pad and wheel wash
10	TEMP TREATMENT FACILITY	1.0	LS	50,000.00	50,000	Packaged filtration and GAC (100 GPM) incl. associated piping, instrumentation, GAC regen/disposal, decon.
11	TEMP STORMWATER RUNOFF TREATMENT/STORAGE TANKS	2.0	MO	2,500.00	5,000	(3) 20,000 Gallon Frac Tanks, rental with associated piping, hookup, decon
12	DIESEL PUMP RENTAL (INFLUENT)	2.0	MO	1,000.00	2,000	6" trailer mounted pump, from remediation area to storage tank
13	DIESEL PUMP RENTAL (EFFLUENT)	2.0	MO	1,000.00	2,000	6" trailer mounted pump, from storage tank to discharge
Earthwork						
4	MANAGEMENT OF DUST CONTROL	2.0	MO	9,000.00	18,000	Dust control over 2 acre work area and 875 LF of access roads
5	HANDLE EXISTING MATERIAL (CUT/FILL)(PUSH)	990	CY	10.00	9,900	Assume average 6" cut/fill over work area
6	BLADE & SHAPE SUBGRADE FOR SOIL COVER	5950	SY	0.70	4,165	Prepare subgrade over entire area to be capped for soil hot spots #1 - #3.
7	SEPARATION GEOTEXTILE (6 OZ NON-WOVEN)	58905	SF	0.25	14,726	Provides delineation between clean soil cover and contaminated soil that remains in place. (10% added for overlap and yield loss)
8	SOIL (CLAY) COVER 24"	5940	CY	20.00	118,800	Compacted clay, 6" lifts, 2% minimum slope
9	TOPSOIL COVER 6"	2215	CY	15.00	33,225	Compacted topsoil, 6" lifts, 2% minimum slope, 4H:1V side slopes
10	SEEDING/REVEGETATION	2.0	AC	2,500.00	5,000	Include surface preparation, discing, seeding, irrigation, and mowing until grass cover is established
Environmental Monitoring and Sampling						
11	AIR MONITORING	1.5	MO	4,500.00	6,750	Air monitoring during grading of contaminated soils
12	TREATED STORMWATER SAMPLING PRIOR TO DISCHARGE	10.0	EA	500.00	5,000	Assume 1 sampling of treated stormwater for Metals, SVOCs, PCB/Pesticides prior to batch discharge
13	PRE-DESIGN INVESTIGATION	1	LS	30,000.00	30,000	Assume 36 samples (12 per hot spot for Metals, SVOC, Pest/PCB, Sampling Plan, Health and Safety Plan, expenses)
Other						
13	HEALTH AND SAFETY	1.0	LS	4,000.00	4,000	Development and implementation of H&S Plan, Activity Hazard Analysis
14	SURVEYING	1.0	MO	10,000.00	10,000	(10) 10-hr. days based on $100 crew hour
15	QUALITY CONTROL	1.5	MO	30,000.00	45,000	6-week duration = 300 man hours + travel & per-diems
16	SUPERVISION	1.5	MO	30,000.00	45,000	
17	CONSTRUCTION REPORT (AS-BUILT DRAWINGS)	1.0	LS	16,000.00	16,000	
18	CONSTRUCTION INDIRECTS	1.5	MO	1,000.00	1,500	Misc. field expenses and expendables
	Subtotal				**494,726**	
19	Contingency	20.0	%		98,945	
	Subtotal - Construction Costs				**593,672**	
20	General Requirements	12.0 %			71,241	
21	Permitting & Legal	5.0 %			29,684	Deed restrictions, stormwater permits, NPDES permitting for discharge of treated water.
22	Services During Construction	5.0 %			29,684	Including field engineering, engineering support, etc.
23	Engineering & Design Cost	10.0 %			59,367	Including project management
	Subtotal - Implementation cost				**189,975**	
	Total - Capital Costs				**783,646**	
	Fee -	12.0	%		**94,038**	
	Total - Proposed Sales Price				**877,684**	
	ANNUAL O&M COSTS					
24	MOWING	4.0	EA	500.00	2,000	
25	SOIL COVER MAINTENANCE/REPAIR	200.0	CY	30.00	6,000	Visual inspection and repair of settlement, erosion, and re-vegetation
26	PROJECT MANAGEMENT (MONITORING & INSPECTION)	40.0	HR	150.00	6,000	
	Subtotal - O&M Costs				**14,000**	
	Contingency	20.0	%		2,800	
	Total - O&M Costs				**16,800**	
	Real Discount Rate	3.1%				30 Year life, Real discount rate of 3.1% from App C of the OMB Circular No. A-94, revised January of 2005
	Net Present Value of 0+M				$325,100	
	Total Net Present Value				$1,202,784	

TABLE B-3: Alternative A-4 - Excavation, Treatment and Offsite Disposal +50/-30 % Cost Estimate

State Marine Site Focused Feasibility Study

Port Arthur, Texas

PRELIMINARY

ITEM	Description	BASELINE QTY	UNIT	UNIT COST	COST VALUE	BASELINE REMARKS
	CAPITAL COSTS					
	Mobilization and Site Preparation and Temporary Facilities					
1	MOB-DEMOB	1	LS	20,000.00	20,000	
2	STAGING AREA	62	CY	25.00	1,550	Assumes 4" thick layer of gravel to be placed on staging area (50 ft x 100 ft)
3	PROTECT & MAINTAIN EXISTING UTILITIES	1	LS	1,000.00	1,000	Survey, pothole locate, and mark
4	IMPROVE SITE ACCESS ROADS (GRAVEL)	162	CY	30.00	4,860	Place and compact 6" of gravel to improve exst dirt site access roads (10 ft wide road x 875 LF)
5	SITE TRAILERS & UTILITIES	3	MO	1,500.00	4,500	Rental of site trailer, utility hookup and monthly fees
6	PORTABLE TOILETS	1	EA	300.00	300	Rental of portable toilet
7	CLEAR AND GRUB WORK AREA	2.00	AC	3,500.00	7,000	Remove trees and brush to 25 ft outside of the perimeter of each hot spot area and to limits of staging area
	Stormwater Runoff Control and Treatment					
8	RUNOFF/EROSION CONTROL (SILT FENCE)	1,900	LF	8.00	15,200	Install 25 ft outside of perimeter of each hot spot remediation area.
9	TEMP DECON FACILITY (CONST, MAINTAIN, OPERATE)	1	LS	15,000.00	15,000	Equipment decon pad and wheel wash
10	TEMP TREATMENT FACILITY	1	LS	50,000.00	50,000	Packaged filtration and GAC (100 GPM) incl. associated piping, instrumentation, GAC regen/disposal, decon.
11	TEMP STORMWATER RUNOFF TREATMENT/STORAGE TANKS	2	MO	2,500.00	5,000	(3) 20,000 Gallon Frac Tanks, rental with associated piping, hookup, decon
12	DIESEL PUMP RENTAL (INFLUENT)	2	MO	1,000.00	2,000	6" trailer mounted pump, from remediation area to storage tank
13	DIESEL PUMP RENTAL (EFFLUENT)	2	MO	1,000.00	2,000	6" trailer mounted pump, from storage tank to discharge
	Earthwork					
14	MANAGEMENT OF DUST CONTROL	3	MO	9,000.00	27,000	Dust control over 2 acre work area and 875 LF of access roads
15	EXCAVATE CONTAMINATED "HOT SPOT" MATERIALS	2,810	CY	5.00	14,050	Excavate contaminated soils (average 2 ft deep excavation, 1:1 side slope)
16	BACKFILL HOT SPOT AREAS WITH 24" CLAY	2,810	CY	25.00	70,250	Backfill excavation (average 2 ft) with clay, compacted in 6" lifts
17	TOPSOIL COVER 6"	1,590	CY	15.00	23,850	Compacted topsoil, 6" lifts, 2% minimum slope, 4H:1V side slopes
18	SEEDING/REVEGETATION	2.0	AC	2,500.00	5,000	Include surface preparation, discing, seeding, irrigation, and mowing until grass cover is established
	Waste Transportation, Treatment and Disposal					
19	SOLIDIFICATION/STABILIZATION OF HAZ-WASTE SOILS	1,054	Ton	60.00	63,225	1.5 Ton/CY, assume 25% of soils fail TCLP for metals, solidification/stabilization (20% Portland Cement) - premium price for sma
20	CHEMICAL OXIDATION OF PCB/PEST HAZ-WASTE SOILS	1,054	Ton	125.00	131,719	1.5 Ton/CY, assume 25% of soils fail TCLP for PEST/PCBs, chemical oxidation performed at off-site treatment facility
21	HAUL TREATED HAZ-WASTE SOIL TO LANDFILL FACILITY	2,108	Ton	44.00	92,730	Assume Hazardous waste transport including permits/manifests ($650/load, 15 ton load)
22	RCRA SUBTITLE C LANDFILL DISPOSAL OF TREATED SOIL	2,108	Ton	150.00	316,125	Assume RCRA Subtitle C permitted landfill facility.
23	HAUL NON-HAZARDOUS SOIL TO LANDFILL	2,108	Ton	20.00	42,150	Assume Texas Class 1 Non-hazardous industrial waste disposal ($300/load, 15 ton load)
24	LANDFILL DISPOSAL OF TEXAS CLASS 1 NON-HAZ SOIL	2,108	Ton	50.00	105,375	Assume Texas Class 1 Non-hazardous industrial waste disposa
	Environmental Monitoring and Sampling					
25	AIR MONITORING	2	MO	4,500.00	9,000	Air monitoring during excavation and grading of contaminated soils
26	SOIL CONFIRMATION SAMPLING	36	EA	500.00	18,000	Confirmation sampling for metals, SVOCs, and PCB/Pesticides.
27	TREATED STORMWATER SAMPLING PRIOR TO DISCHARGE	10	EA	500.00	5,000	Assume 1 sampling of treated stormwater for Metals, SVOCs, PCB/Pesticides prior to batch discharge
28	SAMPLE EXCAVATED MATERIAL TO CLASSIFY WASTE (HAZ. / NON-HAZ.)	6	EA	1,000.00	5,620	Assume 1 TCLP test per 500 CY excavated
29	PRE-DESIGN INVESTIGATION	1	LS	30,000.00	30,000	Assume 36 samples (12 per hot spot for Metals, SVOC, Pest/PCB, Sampling Plan, Health and Safety Plan, expenses)
	Other					
29	HEALTH AND SAFETY	1	LS	4,000.00	4,000	Development and implementation of H&S Plan, Activity Hazard Analysis
30	SURVEYING	1	LS	5,000.00	5,000	(5) 10-hour days based on $100 per crew hour
31	QUALITY CONTROL	3	MO	30,000.00	90,000	
32	SUPERVISION	3	MO	30,000.00	90,000	
33	CONSTRUCTION REPORT (AS-BUILT DRAWINGS)	1	LS	16,000.00	16,000	
34	CONSTRUCTION INDIRECTS	3	MO	1,000.00	3,000	
	Subtotal				**1,295,504**	
35	Contingency	20	%		259,101	
	Subtotal - Construction Costs				**1,554,605**	
36	General Requirements	12	%		186,553	
37	Permitting & Legal	2	%		31,092	
38	Services During Construction	2	%		31,092	Including field engineering, engineering support, etc.
39	Project Management, Engineering and Design Cost	5	%		77,730	
	Subtotal - Implementation cost				**326,467**	
	Total - Capital Costs				**1,881,071**	
	Fee -	12	%		**225,729**	
	Total - Proposed Sales Price				**$2,106,800**	
	O&M COSTS					
40	MOWING	4	EA	500.00	2,000	
41	SOIL COVER MAINTENANCE/REPAIR	200	CY	30.00	6,000	Visual inspection and repair of settlement, erosion, and re-vegetation
42	PROJECT MANAGEMENT (MONITORING & INSPECTION)	40	HR	150.00	6,000	
	Subtotal - O&M Costs				**14,000**	
	Contingency	20	%		2,800	
	Total - O&M Costs				**16,800**	
	Real Discount Rate	3.1%				30 Year life, Real discount rate of 3.1% from App C of the OMB Circular No. A-94, revised January of 2005
	Net Present Value of 0+M				**$325,100**	
	TOTAL				**$2,431,900**	

TABLE B-4: Alternative B-2 - Monitored Natural Attenuation +50%/-30% Cost Estimate
State Marine Site Focused Feasibility Study
Port Arthur, Texas

PRELIMINARY

ITEM	Description	QTY	UNIT	UNIT COST	COST VALUE	BASELINE REMARKS
	CAPITAL COSTS					
Environmental Monitoring and Sampling						
1	BASELINE SAMPLING EVENT	1	LS	30,000.00	30,000	Sampling event to establish baseline for MNA. 10 Bioassay @ $1000 Ea, PCB/PEST, SVOC, Metals.
Other						
2	HEALTH AND SAFETY	1	LS	1,000.00	1,000	Development and implementation of H&S Plan, Activity Hazard Analysis. 10 man hours @ $100/hr
3	SURVEYING	1	LS	1,000.00	1,000	(1) 10 hour days based on $100 per crew hour
4	SUPERVISION	10	HR	105.00	1,050	10 working days @ 10 hr/day, plus per diems, travel, and car expenses
5	BASELINE MONITORING REPORT	1	LS	10,000.00	10,000	
	Subtotal				**43,050**	
6	Contingency	20	%		8,610	
	Subtotal - Construction Costs				**51,660**	
7	General Requirements	12	%		6,199	
8	Services During Construction	10	%		5,166	Including field engineering, engineering support, etc.
9	Project Management, Engineering Cost	10	%		5,166	
	Subtotal - Implementation cost				**16,531**	
	Total - Capital Costs				**68,191**	
18	**Fee -**	12	%		**8,183**	
	Total - Proposed Sales Price				**$76,374**	
	ANNUAL O&M COSTS					
19	PROJECT MANAGEMENT / ANNUAL REPORTS	40	HR	125.00	5,000	
	Subtotal - O&M Costs				**5,000**	
	Contingency	20	%		1,000	
	Total - O&M Costs				**6,000**	
	Real Discount Rate	3.1%				30 Year life, Real discount rate of 3.1% from App C of the OMB Circular No. A-94, revised January of 2005
	Net Present Value of 0+M				**$96,700**	
	ANNUAL SEDIMENT MONITORING COSTS (Year 1-5)					
20	ANNUAL SEDIMENT MONITORING	1	LS	20,000	20,000	Annual MNA performance monitoring. Sample for Toxicity (bioassay) PCB/PEST, SVOC, Metals, report (30 hours @ $
	Subtotal - SEDIMENT MONITORING Costs				**$20,000**	
	Contingency	20	%		4,000	
	Total - SEDIMENT MONITORING Costs				**$24,000**	
	Real Discount Rate	2.0%				5 Year life, Real discount rate of 2.0% from App C of the OMB Circular No. A-94, revised January of 2005
	Net Present Value of 0+M				**$113,100**	
	Total Net Present Value				**$286,174**	

TABLE B-5: Alternative B-3 - Excavation, Treatment and Offsite Disposal +50/-30 % Cost Estimate
State Marine Site Focused Feasibility Study
Port Arthur, Texas
PRELIMINARY

ITEM	Description	QTY	UNIT	UNIT COST	COST VALUE	BASELINE REMARKS
		BASELINE				
	CAPITAL COSTS					
Mobilization and Site Preparation and Temporary Facilities						
1	MOB-DEMOB	1	LS	45,000.00	45,000	Mobilization of earthwork equipment, barges
2	STAGING AREA	62	CY	25.00	1,550	Assumes 4" thick layer of gravel to be placed on staging area (50 ft x 100 ft)
3	IMPROVE SITE ACCESS ROADS (GRAVEL)	162	CY	30.00	4,860	Place and compact 6" of gravel to improve exst dirt site access roads (10 ft wide road x 875 LF)
4	SITE TRAILERS & UTILITIES	5	MO	1,500.00	7,500	Rental of site trailer, utility hookup and monthly fees
5	PORTABLE TOILETS	1	EA	500.00	500	Rental of portable toile
6	CLEAR AND GRUB WORK AREA	1.20	AC	3,500.00	4,200	Remove trees and brush for sediment dewatering impoundment and to limits of staging area
Stormwater Runoff Control and Treatment						
7	RUNOFF/EROSION CONTROL (SILT FENCE)	1,000	LF	8.00	8,000	Install 25 ft outside of perimeter of sediment dewatering impoundment
8	TEMP DECON FACILITY (CONST, MAINTAIN, OPERATE)	1	LS	15,000.00	15,000	Equipment decon pad and wheel wash
9	TEMP TREATMENT FACILITY	1	LS	50,000.00	50,000	Packaged filtration and GAC (100 GPM) incl. associated piping, instrumentation, GAC regen/disposal, decon.
10	TEMP STORMWATER RUNOFF TREATMENT/STORAGE TANKS	5	MO	2,500.00	12,500	(3) 20,000 Gallon Frac Tank rental with associated piping, hookup, decon
11	DIESEL PUMP RENTAL (INFLUENT)	5	MO	1,000.00	5,000	6" trailer mounted pump, from remediation area to storage tank
12	DIESEL PUMP RENTAL (EFFLUENT)	5	MO	1,000.00	5,000	6" trailer mounted pump, from storage tank to discharge
Earthwork						
13	CONSTRUCT CONTAINMENT BERM (CUT/FILL((PUSH)	2,500	CY	10.00	25,000	3ft high x 10' wide containment berm (3:1 side slope) for sediment dewatering impoundment (450 ft x 60 ft), 1000 LF perimeter
14	MIX/TURN OVER SEDIMENT DURING DEWATERING	9,600	CY	5.00	48,000	Use excavation equipment to turn over sediment for drying. Assume 3 month duration for drying (turn once per week)
15	HANDLE EXISTING MATERIAL (CUT/FILL)(PUSH)	2500	CY	10.00	25,000	Demolish containment berms after completion of sediment dewatering
16	SEEDING/REVEGETATION	1.5	AC	2,500.00	3,750	Re-vegetate sediment dewatering area after completion
Dredging						
17	DREDGE CONTAMINATED "HOT SPOT" SEDIMENTS	800	CY	40.00	32,000	Assuming mechanical excavation using a track mounted "marsh buggy", and clam-shell bucket
18	FLOATING TURBIDITY CURTAIN FOR SEDIMENT CONTAINMENT (0 to 12' DEPTH)	400	LF	125.00	50,000	Install around required around work areas, moved/reinstall at each hot spot location (100' x 200' work area)
19	BARGE RENTAL AND DECONTAMINATION	1.0	LS	25,000	25,000	Assume 1000 cy capacity barge for material handling
20	MATERIAL HANDLING / BARGE OFF-LOADING	800	CY	10.00	8,000	Off-load excavated sediments and place in sediment dewatering impoundment
21	LOAD DEWATERED SEDIMENTS FOR TRANSPORT	640	CY	10.00	6,400	Assume 20% reduction in volume from dewatering.
Waste Transportation, Treatment and Disposal						
22	SOLIDIFICATION/STABILIZATION OF HAZ-WASTE SEDIMENT	160	Ton	60.00	9,600	1 Ton / CY, assume solidification/stabilization with min. 20% Portland Cement Reagent - premium price for small quantity
23	CHEMICAL OXIDATION OF PCB/PEST HAZ-WASTE SOILS	160	Ton	125.00	20,000	1 Ton / CY, assume 25% of soils fail TCLP for PEST/PCBs, chemical oxidation performed at off-site treatment facility
24	HAUL TREATED HAZ-WASTE SEDIMENT TO LANDFILL FACILITY	320	Ton	44.00	14,080	Assume Hazardous waste transport including permits/manifests ($650/load, 15 ton load)
25	RCRA SUBTITLE C LANDFILL DISPOSAL OF TREATED SEDIMENT	320	Ton	150.00	48,000	Assume RCRA Subtitle C permitted landfill facility.
26	HAUL NON-HAZARDOUS WASTE TO LANDFILL	320	Ton	20.00	6,400	Assume Texas Class 1 Non-hazardous industrial waste disposal ($300/load, 15 ton load)
27	LANDFILL DISPOSAL OF TEXAS CLASS 1 NON-HAZ WASTE	320	Ton	50.00	16,000	Assume Texas Class 1 Non-hazardous industrial waste dispos
Environmental Monitoring and Sampling						
28	SURFACE WATER QUALITY MONITORING	20	EA	500.00	10,000	Turbidity monitoring, SVOCs, Metals, PCB/Pesticides. (Assume 1 sample / day during mechanical dredging)
29	SEDIMENT CONFIRMATION SAMPLING	30	EA	500.00	15,000	Confirmation sampling for metals, SVOCs, and PCB/Pesticides, assume 10 samples per hot spot area
30	TREATED STORMWATER/SEDIMENT DECANT SAMPLING PRIOR TO DISCHARGE	25	EA	500.00	12,500	Assume 1 sampling of treated stormwater for Metals, SVOCs, PCB/Pesticides prior to batch discharge
31	SAMPLE EXCAVATED MATERIAL TO CLASSIFY WASTE (HAZ. / NON-HAZ.)	5	EA	1,000.00	5,000	Assume 1 TCLP test per 200 CY excavated
32	PRE-DESIGN INVESTIGATION	1	LS	40,000.00	40,000	Assume 40 samples (12 per hot spot for Metals, SVOC, Pest/PCB, Sampling Plan, Health and Safety Plan, expenses)
Other						
32	HEALTH AND SAFETY	1	LS	4,000.00	4,000	Development and implementation of H&S Plan, Activity Hazard Analysis
33	SURVEYING	1	LS	5,000.00	5,000	
34	QUALITY CONTROL	4	MO	30,000.00	120,000	
35	SUPERVISION	5	MO	30,000.00	150,000	
36	CONSTRUCTION REPORT (AS-BUILT DRAWINGS)	1	LS	16,000.00	16,000	
37	CONSTRUCTION INDIRECTS	5	MO	1,000.00	5,000	
	Subtotal				**878,840**	
38	Contingency	20	%		175,768	
	Subtotal - Construction Costs				**1,054,608**	
39	General Requirements	12	%		126,553	
40	Permitting & Legal	10	%		105,461	
41	Services During Construction	2	%		21,092	Including field engineering, engineering support, etc.
42	Project Management, Engineering and Design Cost	5	%		52,730	
	Subtotal - Implementation cost				**305,836**	
	Total - Capital Costs				**1,360,444**	
	Fee -	12	%		**163,253**	
	Total - Proposed Sales Price				**$1,523,698**	
	O&M COSTS					
	Not Applicable					
	Subtotal - O&M Costs				**0**	
	Contingency	20	%		0	
	Total - O&M Costs				**0**	
	Real Discount Rate	3.1%				30 Year life, Real discount rate of 3.1% from App C of the OMB Circular No. A-94, revised January of 2005
	Net Present Value of 0+M				**$0**	
	TOTAL				**$1,523,698**	

005746

(This page intentionally left blank.)